ADVANCED MANUAL OF TEACHING

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ADVANCED MANUAL OF TEACHING

FOR TEACHERS OF ELEMENTARY
AND HIGHER SCHOOLS

SPECIALLY ADAPTED TO THE NEW CODE

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Erratum

Page 45, *for* influx *read* reflux

HOW TO TEACH PHYSICAL GEOGRAPHY.

INTRODUCTION

SOME time ago I tried to show you how you should teach general geography to young children. You are now taking up 'physical geography,' as a 'specific subject,' under the fourth schedule of the code. You may fairly ask: 'Is this a new subject, or is it a continuation of the former? Am I to begin afresh, or to go on where I stopped, and add further and fuller information? It will be very good for you and for your lessons to think well over these questions and get the answers clearly into your mind.'

2. **What is Physical Geography?**—Strictly, it is not a new subject, nor yet is it a mere sequel. Look over the schedule; you see at once that it contains many of the same things with which you have been dealing already. *Rivers, ocean, form and motions of the earth*, these are your old friends. But, along with these, are many new terms, such as *evaporation, condensation, tides, planetary system*, &c., with which you had little or nothing to do in your earlier and simpler lessons. What is the real distinction? Stop and think! You have, no doubt, 'got up' all the points noticed in the schedule, and have perhaps 'passed' in physical geography. But you may have done all this, and yet never had clearly in your mind what physical geography really is. You

may have taken each point separately, as so much to be got up for examination, and never stopped to ask yourself how they are all linked together as parts of one great subject, or how this subject differs from that elementary geography with which it has so much in common. If so, you may have 'passed' well; but you do not really know much about it. And, if you go on to teach in the same way, you may 'pass' your scholars; but you will have done them very little good. Bear this in mind at the outset: the two great enemies of sound knowledge—the giants in your path—are giant '*Cram* and giant '*Sham!*' They are closely related to each other. '*Cram*' is loading the memory with words and phrases which the scholars do not understand; '*Sham*' is the appearance of knowledge, got up for effect, without a real foundation. All this I have said before; but it is still more needful now, because from the nature of the subject the temptation is stronger, and the danger more serious.

3. The real distinction is, that whereas in the elementary lessons you had to deal chiefly with *facts*, you are now to explain causes. Keep this steadily in view, and you will be proof against giant '*Cram*' and giant '*Sham*.' It will show you that every definition, technical phrase, or formula, must be taken to pieces and reduced to simple every-day words before it can be given to children. And it will show you also how what looks in reading the schedule like broken fragments of the subject are really links in a chain, one leading up to the other, and every one necessary to enable us to understand the rest. You will then come to value the foot-note which directs you to train the children to 'exercise their own powers of observation,' and to express 'in their own language the ideas they have formed of what they have seen.' It would be well if this direction were more generally carried out in spirit as well as in the letter!

4. Now let us look for a moment at the schedule as a whole. If you have gone far into the subject, you will see that these three sections do not cover the whole ground.

They contain as much as it has been thought possible to teach in a limited time; but a great deal is left out, which is in itself important, and some part of which you will be obliged to touch upon, in order to make your teaching on other points clear. Such are mountains, valleys, plains, plateaux, ice in all forms, climate, and the influences which affect it, &c. Of these you may not be able to say much, but you should have them clearly before your own mind. Even when you do not mention them, and so they do not appear on the surface, they will supply an under-current of thought, which will give point and exactness to what you say.

5. **Principles of Sound Teaching.**—One word more. You must have often felt how many things a good physical geographer ought to know! He must go to astronomy to explain the planetary system, to geology to tell him the structure and history of the land and ocean, to chemistry and physical science for what is known of the composition of the atmosphere and all that takes place in it. Am I, then, you may naturally ask, to get up all these sciences? Or how else am I to escape the charge of '*Cram*' and '*Sham*' if I take for granted facts and principles which rest on these sciences for their proof? Here is my answer, 'A little learning, they say, is a dangerous thing!' Yes, but only when the possessor of it mistakes the little for a great deal. A little, well digested, may do good service. You may not know enough of mathematics to follow the *proof* of the theorem, that the elliptical orbits of the earth and other planets 'are necessary consequences' of the law of gravitation,[1] but you can make yourself master of the *fact*: you can understand generally the nature of an ellipse, and you can see how this form of the orbit arises from the laws of motion, even though you are unable to trace the full proof of those laws. Or, again, you may not be a practical geologist or chemist,

[1] See Stubbs's *Astronomy*, p. 220.

you may have no skill in experiments, and may have done little or nothing in examining the structure of the earth. So much the worse! You lose a great deal as a teacher; and if you are still young enough to begin, I would advise you to take or make time for both studies. We shall see hereafter how they would help you. But still, even without this practical knowledge, you may follow and be able to explain the experiments or observations of others. Only be careful to avoid the two besetting sins of young teachers: *Do not be content with meagre outline, because it needs some hard work and thought to fill it in with life-like colouring; and do not fancy that you understand scientific teaching, till you can clothe the teacher's thoughts in freely chosen words of your own.*[1]

[1] See Huxley's *Physiography*, Preface, p. vii.

CHAPTER I.

RIVERS.

6. **Order of Teaching.**—You are told, in the foot-note to the schedule, that the three stages of this subject may be taken in any order. But it will be most convenient to take them as they are set down; though you can, if you like, miss the first, or the first and second, and begin where you please. Something may depend on the locality. If you are living on the coast, you might naturally take the ocean first; if speaking to the children of mountain-shepherds, accustomed to watch the face of the sky, you might deal first with the place of the earth in the universe, its shape, motions, and relations to sun and moon. The great rule is, begin with what is familiar to children, train them to observe and to think about what they see, and so advance from the known to the unknown. Under this rule, however, much oftener than not, you will find it most convenient to take the sections as they stand. For one child who can see the sea from its own home, there must be a hundred who can watch the flow of a river.

7. **Running Water.**—'Yes,' you may say, 'but I happen to live in a flat midland country, away from the sea, and with no river close at hand. How am I to find anything to start with, within the children's own observation?' A hard question, if you are going to teach by 'definitions' and formal phrases. Easy enough, if you have a firm hold of principles. Take your scholars to a road, or draw from them

what they have seen there during or after heavy rain. The little channels formed by the rain-water are a model on a small scale of the course of the mightiest river.[1] Show them how each little thread of water runs steadily downwards, how they join together to form larger streamlets, how they are affected by stones or other obstacles, and never stop till they fall into a brook, or running ditch, or drain; show them all this, and when you begin to explain the reason why, you will find that you have got all at once into the great physical principle of gravitation—the special form, which most concerns us at present, of the larger principle of attraction.

8. You will have to spend some time on this subject in the third stage, in explaining the relations of the planets and their orbits. But it will be well to take some pains at once to make this law of nature clear to the children, if for no other reason, because the fact itself is so simple and so constantly before their eyes; so simple, indeed, that every boy in the class has seen it, and yet not one, most likely, has ever stopped to think about it. You will thus be showing them, not only one great truth, but also, by a single example, how common things are governed by unchanging laws. For the moment you have to do with attraction only in the one form, as causing all bodies on or near the earth's surface to be drawn towards its centre. Explain this clearly, and illustrate it by any easy experiments that occur to you; making sure, first of all, that it is quite clear to your own mind. This, of course, means that you have yourself gone much more fully into it; and that, even if you have not mastered the mathematical proof, you at least understand how the same law of attraction, that makes the streamlet trickle, binds the universe together, and governs the planets in their courses.

9. But all bodies do not roll down the slope as water does. Why is this? The loose stones and the gravel and

[1] See Geikie's *Physical Geography*, §§ 155–159.

the soil lie still on the roadside. Why does water only run down till it finds a level? The full answer to such a question would include too much for your present purpose, and perhaps too much both for you and your class. It will be enough for the present if you show them generally the distinction between a fluid and a solid, and how the particles of the former, being less closely welded together, can in a moment change their form and shape as required, and so find or force their way round or over or under or through obstacles which would stop a solid body. This really needs but little explanation. But it will not be wasted time if you give half a lesson or so to bring out this distinction sharply and clearly; it will help them to remember that gravity is a *universal* force, and it will prepare them for the further distinction in future lessons between a *fluid* and a *vapour*.

10. **Work of Water.**—From this I think you should go on to what is called the *work* of running water; *i.e.* its power of carrying solid matter with it, of wearing away soil or rock on its banks, and of breaking down even strong barriers lying across its path, if pressed by accumulating waters behind it, and finding no easier channel. Under each of these heads there is a great deal to be said; to go fully into them, some knowledge of geology is needed. Read carefully Professor Huxley's chapter on this subject,[1] or anything similar; you will there find what you need about *detrition*, *denudation*, and *mechanical power*. Do not, yet at least, trouble the children with these hard words; the second may be needed at last, but you can do without any of them at this stage. You may perhaps be able to illustrate these points, or at least the first and second of them, by taking your class to a neighbouring stream, and showing them the rounded hollows on the banks or in the bed, and other marks of the action of water in dissolving and rubbing down the rocks through which it has

[1] *Physiography*, chap. ix.; or Bonney's *Manual of Geology*, chap. iv.

forced or worked its way.[1] But make the facts clear, and show how they serve to explain the *deltas* at the mouths of rivers, and the *gorges* through which they often run. If you have any skill in perspective drawing, try to copy the engraving given by Professor Huxley (fig. 32, p. 136) of the Great Cañon, Colorado. Here also you have an opportunity —and you will not have many—of enlivening your teaching by story or anecdote. *If you can*, choose those which are connected with your own neighbourhood—what you have seen or been told—rather than what you have read about. But this is not essential. The Moray floods of fifty years ago, the Holmfirth flood in Yorkshire of 1852, if you happen to have heard about them, would serve the purpose extremely well. *Any* well-told story of real life, bringing out the power of water for destruction, would help the memory, and relieve the dry details of scientific teaching.

11. **Starting Point.**—Now, at last, for the actual river. You can trace it either from source to mouth, or from mouth to source. The latter order will be the more convenient, as you have already been speaking of deltas, and still more because from the source you will have to ascend still higher, and trace its real beginnings in the watery vapour of the atmosphere. I begin, then, with the mouth, yet not exactly at the point where the river loses its name and is swallowed up in the ocean. The *estuary* has so much in common with the sea, especially the tidal motion, that it properly belongs to the second stage rather than the first. The starting-point for a river, going upwards, is the point at which the tide ceases to arrest the flow of the stream, that is, for the Thames at Teddington, for the Severn a little above Gloucester, and so on for each particular river. Above that point, you have to consider *direction*, *length*, *basin*, *watershed* or *watersheds*, *source* or *sources*.

[1] See Bonney's *Manual of Geology*, pp. 51–55.

12. **Basin.**—Here there are still two possible methods. You may treat each point in a general way, or (so to speak) in the abstract, illustrating your general principles by examples. This is the most usual method, and *seems* the most complete, but it is dry. Far more telling is that for which you have the very high authority of Professor Huxley,[1] who bases his whole view of physiography on a minute examination of the basin of the Thames. I advise you to follow his method and his order. If you happen to live in that basin, you have simply to reproduce the model he gives you, adapting it to the wants and capacities of the class you are teaching. Some things may have to be left out: you would not, for example, attempt to give to your class, and, indeed, you hardly could give them, his description (pp. 12–14) of the different methods in map-drawing of indicating relative heights. But, on the whole, the more closely you follow his method, the more effective will be your teaching. Your class ought, when you finish this part of the course, to have a clear view of the basin as a whole, and of its several parts. You will not forget to remind them, from time to time, of the illustrations you meet with of the 'power and *work* of water.' For those who do not live near the Thames, or any other large river, the same course is still the best. As you *cannot* appeal to what the children have seen, the next best thing is to take the river which all have heard of, and which every English child cares most to hear about.

13. But, if you live near any other considerable river, as the Severn, the Yorkshire Ouse, the Tyne, or the Eden, I think you should first of all set yourself a more difficult task. Take this exposition of the Thames basin as a model not to *copy*, but to *imitate*; and try your best to do for your own river what has here been done by a master-hand for the great river of England. The lines are marked out for you, and they are not very hard to follow, if you take pains enough. Your chief difficulty will be to get up the local

[1] *Physiography*, chap. i.

knowledge. To this I can only say, *Do your best!* Work hard for it, look out for information from books, from hearsay, from personal exploring. Your picture will not, after all you can do, be as perfect as Mr. Huxley's, but it will be a great deal better than if you had not been provided with so good a guide.

14. In either case—and this goes far to equalise the conditions for all teachers—you should follow up your first river-basin with a second. If you have already taken the Thames, choose now any other in England or Wales; if you have begun with a local river, now take the Thames. Make these lessons a recapitulation of principles, and so far a revisal of what has been learnt, with an application of fresh facts. You ought then to be able to go forward with confidence, feeling tolerably sure that, when you come to examine your class at the end of the school-year, you will find them able to answer intelligently on river-basins in general, and these two more particularly.

15. **Boundaries.**—There still remain the boundaries of the other 'great river-basins of England'—that is, I presume, 'of England and Wales.' These, I think, they should get up for themselves. For, while '*cram*' is a thing to be avoided, it is always well to put scholars, especially older scholars, to do some part of the work for themselves. It is perhaps the weak side of our present modes of teaching, that we do too much for them, and throw them too seldom on their own resources. The self-taught student has many dangers, and must often make mistakes, which he may not always discover soon enough. But he has one thing on his side; what he has learnt, he has learnt! When he has fought his way through difficulties by his own energy and brain-work, he has a firm grasp of his results, and can never lose hold of them. It should be our aim to combine the advantage of well-timed help with the self-reliance of those who have really *worked* for their knowledge. So, here—

though this is but a small instance—there is something for them to do. You will find in the 'Physiography' (p. 20) a very good map of Great Britain, divided into river-basins.[1] Copy this, or any similar map, on the black board, with coloured chalk for the divisions; make the boys copy it carefully, with special attention to these divisions; they should then be able to get up all the details without further assistance.

[1] You will observe in this map, as also in that of the Thames, that rivers running into the *estuaries*, as the Medway or the Wye, are counted as having separate basins of their own. As tributaries, they *might* be included in those of the principal rivers; but this way of looking at them agrees very well with the plan of reserving Estuaries to be taken with the Ocean rather than with the River.

CHAPTER II.

SPRINGS.

16. So far, we have been dealing with the *surface-water* of a country, and we have seen how the great body of water which pours into the sea at the mouth of a river is made up of a vast number of smaller streams issuing from hills and mountains, and running down their sides by the force of gravity. The next question is, Where does this water come from? What feeds the streams that they may feed the river? Any boy can answer, 'The rain!' And, perhaps, out of any fairly intelligent class, you may be able to get the further answer, that besides the rain-water which trickles and then flows down the slopes, there is also another supply—that which oozes out of the earth on the hill-side or at its foot, or even in the plain. These *springs* feed the streams: what forms and feeds the springs?

17. **Rocks.**—The answer to this question takes you into geology. All that you absolutely *need* is very easy. You must know the geological meaning of the word Rock; you must understand the difference between *permeable* and *impermeable* rocks; you must have learnt how they lie in *layers* or *strata* of different thicknesses, and that these *strata* are seldom horizontal, but slope at an angle called the *dip*. All this you *might* get up, so as to teach it with tolerable clearness, even without knowing more about geology. But, if you want to teach with confidence, and to be sure that you understand each point, you must go farther than this. You must master

at least the leading principles and facts of geology, so as to see for yourself how the little bits of the science, which you need for your present purpose, are connected with larger views of the structure of the earth and the history of its formation. You should be able to tell your class which of the 'rocks' found in your own neighbourhood are 'permeable' and which 'impermeable;' and in order to do this, without making mistakes, you must know the geological name of each, and something about its place in the history of the earth. A visit to a railway cutting, or a quarry, or wherever you can find an exposed '*section*' of rocks, will do much to clear your ideas, if you can go in company with a competent guide, and know something to begin with of the rocks you are likely to find there. If you can take some of your best boys with you on a second visit, so much the better. If not, or indeed in any case, draw for them a sketch of the section, exact enough to show how the different rocks rest on each other, and coloured to show the lines of division between them. When they have this clearly in their minds, they are ready to understand how springs are formed.

18. **Theory of Springs.**—The theory of springs is, indeed, now very simple; and if taught with the aid of good diagrams, is sure to be interesting. Teach it in three stages:—1. The case where the permeable or porous rock rests upon the impermeable, as a bed of gravel on a bed of clay. 2. Where the impermeable rock is uppermost, then the permeable, and then impermeable again: show specially in this case how the '*dip*' is necessary to the formation of springs. 3. Where there is a double dip—two slopes meeting in a hollow—so that water accumulates below, forming natural reservoirs, from which a supply can be obtained by boring; the water rising in the tube to the level of its source, and so forming what is called an artesian well. The last case is not needed in connection with the supply of rivers; but it completes the answer to the question, 'What becomes

of all the rain?' It is also in itself interesting as explaining the *principle—not the method*—on which water-works in towns are supplied; the principle or law that water under pressure from water will rise to its own level. You do not see it rise on the surface, because it is almost sure everywhere to find a downward outlet; or if it does not find one, it will scoop out one for itself. But let it be shut in in a hollow underground, with water pouring in behind it, then open a tube pointing perpendicularly upward, the water will rise till it reaches the level from which the pressure comes. To *prove* that this must be so, is no part of your present duty; study the proof, *if you can*; but, anyhow, it is easy to make town children at least see that it is so; that, while water in a basin will not rise an inch in a tube, water does run up the pipe along the wall of a house, and fill the cistern at the top. Fountains also—or many of them—are supplied in the same manner; the force which makes them play is the pressure many feet below from streams running for miles under ground. As an exercise for thought, and as a test of clear understanding of this matter, I propose to you this question, with which you may try the intelligence of your class. It is noticed by Huxley,[1] that from the well at Thames Head 3,000,000 gallons are every day *pumped up* by the engine. Why is it necessary to pump it? Why cannot they sink an artesian well?

19. Artesian wells, however, and their principle, though I have spoken of them first, must come last in actual teaching. The formation of the real spring must come first. Here the diagram is almost everything: if it is clear and accurate, nothing can be easier than to explain the process. The only force is gravity; the only principle, that water will trickle down wherever it can find a channel, but that some substances are of such close texture that (except when broken, so as to leave cracks or *fissures*) there is no room for water to pass.

[1] *Physiography*, p. 37.

20. I am afraid it is useless to bid you go and examine for yourselves the sources of your own river, so as to give the same sort of minute account of them which Professor Huxley has given of those of the Thames.[1] If you can find a spring of sufficient size in your own neighbourhood, or explore one in your holidays, you might turn such local surveys to good account. What you have seen will always tell more than what you have read. But you may do without it.

21. It now becomes a question whether you should stop here and go on with the other parts of the subject, or take the principles you have laid down, and apply them to rivers on a larger scale, such as the Nile, the Mississippi, or the Amazon. With a fourth standard, who are only beginning to learn any geography beyond the limits of the British Islands, I do not think much could be gained by examples taken from countries beyond their knowledge. In any case you can reserve this for your recapitulation towards the end of the year; and then, if you had time, there is no doubt that you would be able, from these giants among rivers, to give more point to what you have been saying about the work and power of water. *Denudation* especially, which in British rivers is now little more than a theory, is there an unmistakable reality.

[1] *Physiography*, pp. 35-38.

CHAPTER III.

THE ATMOSPHERE.

22. You have now come to a point where it is more than ever necessary to keep in mind the cautions I gave you at the outset. So far you have been dealing with subjects in which, though there is much for you to learn, there is also much to recall to you the simple lessons of general geography. You are now to speak of the atmosphere, its composition, movements, and watery contents, matters of which, till you took up this subject, you knew nothing, or next to nothing, and of which the children can know nothing except what you may tell them. There is great danger of sliding into the use of 'cram' phrases, from not being very sure of your own knowledge, and feeling afraid to venture far beyond the very words you have been taught. To escape this danger, determine first *exactly* how much you have to teach, and then try to have those particular points fully and clearly in your mind.

23. **Extent of Subject.**—You have explained to them the nature of springs, and in doing so you have answered the question, What feeds the rivers? Now comes the question, What feeds the springs? You have shown them that it is the rain. What, then, is rain? Why does it fall? Why is it not always falling? Then, again, what are the clouds, from which the rain comes? These are the next questions you have to answer; and in answering them you will have to speak of the composition of the atmosphere itself, and of the winds which

govern, to a large extent, the rainfall of different countries. Here are *four* distinct subjects—*rain, clouds, air, wind*; and each of these, as you may see in your text-books, branches out into several parts: *rain* leads you to snow, dew, hail, mountain ranges; *clouds* are of different kinds, and closely akin to mist and fog; *air* suggests many questions about its varying heat, density, and weight; and *winds* cannot be properly explained without referring to the motions of the earth. You cannot teach all this. If I told you to try it, I could not be surprised if you answered, 'No; I cannot possibly do so much; so I will not try, but be content with getting up the cram work of the text-book.'

24. **Watery Vapour.**—Let us see if we cannot make matters easier. What you really have to teach may go into smaller compass. I should begin with the leading facts. That there is always in the air a certain amount of invisible watery vapour, is easy to explain, and not difficult to illustrate. I should not at present go far into the subject of evaporation; leave that for a little. It is enough for the moment to let them understand that these watery particles are there; it will be time enough, farther on, to tell them how they came there. You can illustrate the fact by common examples, showing them that the air *holds* the vapour, just as a sponge holds water; and this illustration will bring out the further very important truth, that it can only hold a limited quantity. Other illustrations may occur to you; the more the better if they are to the purpose, only be careful in choosing them. To 'illustrate' is to throw light upon what is dark; but a bad illustration—*i.e.* one which misses the principle of what you are teaching—may only make it darker than before. The truth itself is very simple, that in the air we breathe there is always, though we do not see it, any more than we see the air itself, more or less of watery vapour out of which rain is formed; it is not *part* of the air, but is held by it and in it, as water is held by the sponge.

25. **Composition of the Atmosphere.**—This brings you at once to the 'composition' of the air; a very wide subject, and one well worth dwelling upon for many reasons. But, for the purposes of physical geography, you do not need to go far into it. The proportions of the different elements are to be found in all the text-books,[1] and present no real difficulty. You may, however, need some patience, not in making the class learn the figures—that is easy enough—but in making sure that they take in the general idea of proportionate parts. Do not take this for granted, especially with a fourth standard; but try them with one example after another, till you are *certain* that they know what they mean, when they tell you that air consists of so many parts of oxygen and so many of nitrogen, &c. It would be well also that they should know, though I doubt your getting the thought very clearly into their minds, that the oxygen and nitrogen of the atmosphere are simply *mixed*, and not chemically combined. If your knowledge of chemistry enables you to show this by experiment, it is worth doing; if not, I rather think you had better let it alone.

26. *If you have time*, it is well worth while to show your class, by a few simple experiments, something about the properties of these elements. Oxygen in particular, as supporting life and combustion, will well repay your trouble, and bears (as I suppose you know) on the composition of water as well as of air. But, simply with a view to physical geography, and to the points noted in the fourth schedule, you need not dwell long on this. The main facts which you have to do with concern the air as a whole, and do not require you to look closely at the separate elements. These should be *known*, but may be treated slightly and briefly.

27. **Weight.**—So also with the *weight* and pressure of the atmosphere. You *might* here bring in the whole theory

[1] See, for one, Ansted's *Physical Geography*, chap. xii. p. 233.

of the barometer, and a vast number of scientific truths and theories, all bearing on physical geography in its widest sense. But you will do well to pass these by, and fix attention mainly on the *fact*, that the air *has* weight and is also *elastic*, and therefore presses on all objects round it. You should carefully explain the exact force of the word *elastic* as here used, and how a *fluid* or *vapour* differs from a *solid* in pressing every way instead of downwards only.[1] You should show, if possible by experiment, how this pressure is measured; and, while doing so, you will bring out the fact that it varies exceedingly, according to the height of each place, the temperature of the air, and the amount of watery vapour present at any given time. Fix the attention on the two last points; they are bringing you back to the sources of rain. You may get great help here also from the barometer, simply as putting clearly before the eyes of the children the changing amount of pressure. But lay stress mainly on the fact that heated air is lighter than cold, and has therefore a tendency to rise. You may illustrate this by the ventilation of a room. Point to the 'ventilators' at the top of your schoolroom, and ask how they work. The answer must be, because the breathed air is heated and therefore lighter for the time. Suppose, then, you are asked, *Why is it lighter when heated?* The answer is, that heat expands or spreads the particles of air, and therefore leaves fewer of them, or less weight in the same space. This, as I suppose you know, is the key-note of the whole theory of wind; and, together with another fact, is also the key-note of that of rain. That other fact is, that heated air can hold, and therefore absorbs, more watery vapour, and this vapour (being, you will remember, *lighter* than dry air) increases the upward tendency. From which it plainly follows, that if once there is a body of heated air containing moisture near the earth's surface, it *must* rise and carry the moisture with it, to remain in the upper region of the atmosphere

[1] See Huxley's *Physiography*, pp. 87–92.

till it cools. You may now see your way. You have only to show why the air near the earth's surface should be warmer than higher up, and you will have all clear up to the point at which the moisture or vapour is floating in the upper regions, ready to be condensed into clouds.

28. **Radiation.**—I still advise you to defer the subject of evaporation. You have to speak of the radiation of heat; and as the two processes go on together, and have some points in common, there is danger of your young beginners in science mixing them up in their thoughts. Keep the one process clear; describe and illustrate *radiation* of heat as what is going on constantly from one object to another; then apply this specially to the passing of heat from the sun to the earth, and from the earth to the air lying nearest to it, explaining and proving by experiment [1] that the air is *not* warmed or hardly warmed by the heat that reaches it from the sun, which merely passes through, but almost entirely by that which comes back to it from the heated earth. This is the last link in the chain, and it is now (so far) complete. The sun warms the earth; the earth warms the lower air; the heated air ascends, carrying the watery vapour which it contains; the particles of vapour are thus lodged in the upper regions. What becomes of them there, and what makes them come down again? In all this, what you have to do is to explain to the children the meaning of what is taking place every day all around them, the common things which they have known about all their lives without ever thinking of the reason why.[2]

29. **Condensation.**—Now for the clouds; or, generally, for the process of condensation. Observe the meaning of the word; it throws light upon the process. To *condense* is to make denser, that is, more compact or closer-grained. Heat

[1] See Geikie, § 64.

[2] For simple illustrations see Geikie's *Physical Geography*, §§ 45-65.

expands or scatters the particles more widely; the withdrawing of heat brings them closer together; therefore, heat makes them lighter, cooling makes them heavier; and when they are heavier they must, sooner or later, come down.

30. Condensation takes place in different forms in mist, fog, dew, clouds, rain, snow, and hail. These divide into two classes—the first three being due to condensation near the earth, the last four to condensation up in the air. You must choose in which order you will take them. I greatly prefer going at once to the clouds because of their greater importance, and because it is to them that you must look for an answer to the question, 'What feeds the springs?'

31. **Clouds.**—You must now recall to the minds of the children one statement about the watery vapour of the atmosphere, on which we did not dwell at the time. It is *invisible*; you cannot see it till it is partly condensed, and so the mark of condensation is that you begin to see it. Show this by the familiar example of the glass of very cold water brought into a warm room. Let the children see after a while the drops forming *outside* the glass, and let them try to find out for themselves where these drops come from. They will guess wrong at first; most likely some will say that they ooze through the glass. Lead them on if possible to see that the moisture was in the air of the room, though they could not see it, and that it is now *condensed* by the coldness of the surface of the glass. Make it clear that the water *in* the glass has nothing to do with it, but is wanted simply to produce the coldness; then bid them look up to the sky. They see the clouds; these are, in exactly the same way, formed in the upper atmosphere by its coldness, from the vapour carried up to it by heated air from below, and are ready ere long to run down in rain as the drops run down the outside of the glass; and just as they *saw* the drops, though before they could *not* see the watery particles in the air of the room, so in the sky they *see* the clouds, 'as

visible vapour suspended in the air at some distance from the earth.'[1] I quote this, as a good and brief definition; but do not give it to your class till you are sure that they understand what clouds are. *Then*—but not till then—it may help them to remember.

32. Now, suppose at this point a boy were to ask you, 'Which is heavier—water or air?' you must of course say, 'Water.' Then, if he asks again, 'Why, then, do not these watery drops, which make the clouds, run down at once, as the drops ran down the glass?' what shall you say? Perhaps you will be puzzled: in fact, if you are not puzzled at first, I should think that you had either gone very deeply into the subject, or (as I am afraid is more likely) have not gone deep enough. Well, having thought it over, what are you going to say? You might very fairly say, 'I don't know'; and this would be by no means the worst answer you could give. 'Cram' would have an answer ready; only it might make the boy no wiser than before. 'Sham' would answer something, not much caring what it was, anything rather than confess to ignorance. But be sure it is not only a nobler and more honest thing to confess that you do not know, but it is also by far the wisest thing for a teacher. It gives the class confidence that, when he seems to know, he really knows; and that they may take all he tells them without doubt, and ask questions freely without fear.

33. In truth, your '*don't know*' is in some sense what Science herself has to say about the clouds and their suspension in the air.[2] There is much that we do not perfectly understand. But the main principle seems clear enough. Go back to the illustration. The drops did not appear all at once on the outside of the cold-water glass; there was first a dimness or mist on the bright surface, and then after a while came the drops. So, you have *first* the clouds, 'visible vapour' *partly* condensed, but not yet actual water;

[1] Ansted, p. 270.

[2] See Huxley, p. 41; Ansted, p. 272, &c.

then, their small particles run together, form larger and heavier drops, and at last come down as rain.

34. Something like this is the real truth of the matter, so far as we know at present, or at least as much of the truth as you can hope to make clear to your children. You can then test their knowledge by tracing the application of the same principles to the other forms of condensation—viz. snow, hail, mist, fog, dew. You will show them how mist and fog are really clouds at a lower elevation; how dew is vapour condensed close to the ground; how snow and hail are different forms of that vapour, yet further condensed or *crystallised.*

35. I am here giving you a mere outline, or a chart of your way; and, like most outlines, it is very dry reading: an *itinerary,* or list of stations from 'Bradshaw,' may sometimes be interesting, but is certainly not amusing. But there is no reason why your lessons should be dry. If all has gone well so far, you may well spare time to introduce a few illustrations to enliven your course. The different forms of Cloud,[1] their grotesque or fanciful or picturesque colouring, the shape and composition and varied beauty of a snow-flake,[2] these and such like *side-views* of this department of Nature, though not strictly needed for your purpose, and utterly hateful to giant Cram, will well reward you for any time you give to them, by brightening up your scholars, and leading them to see how behind the hard words of Science there is the living face of Nature.

36. **Winds.**—So far of the clouds and the rain that falls from them, as if they were always hanging over the same spot, drinking in the moisture which rises from it, and returning it in due time in the form of rain. In point of fact, you know, it is not so: the clouds are almost always in motion, so that the moisture drawn from one quarter is showered down on

[1] Huxley, pp. 42, 43; Ansted, pp. 274–278.
[2] Huxley, pp. 60, 61.

another. What makes them move? You will say, 'The Wind.' True in a sense; though, strictly, it is not true that the clouds move *before* the wind, as we are apt to speak. Wind is air in motion; and the moisture, condensed or uncondensed, is *in* the air and moves with it and in it. Still, in a general way, we may be content to say, the wind makes the clouds move. But what causes the wind? What makes the air move? A large subject, which you must now do your best to open out.

37. Here, I need hardly say, what we know is but a small part of what there is to be known; and of what we know it is but a small part that you can hope to make clear to children. What you can do is to let them see the general causes of wind, and to trace the way in which they work in one or two of their simpler applications. You may take them in these four classes:—

1. Those which depend simply on changes of temperature;
2. Those which also depend on the earth's rotation;
3. Those which are also affected by the seasons—*i.e.* by the sun's apparent path in the heavens;
4. Variable winds, for which at present no very clear rules can be given.

The first class includes land and sea breezes;
The second, the trade winds;
The third, the monsoons;
The fourth, the changeable winds of the temperate zones.

38. **Land and Sea Breezes.**—Under the first head, you can best explain the great principle. Picture out an island lying alone in the ocean[1]—St. Helena, if you like, or Juan Fernandez: it is always best to take an instance that has a story—and describe the alternate rush of cold air from the sea to the land, and from the land to the sea. Show

[1] See Guyot's *Earth and Man* (English Translation), p. 68. The whole chapter is well worth attentive reading.

clearly the reason why; how it arises from the two facts, that heated air must rise, and that land is more readily heated and more quickly cooled than water. You have here, you see, the working of these causes without interference; there is no other cause or influence to be taken into account; and you have here, therefore, the simplest and most regular form of wind. Before you leave it, the whole class should be able to give intelligent answers to the questions: 'What is Wind?' and 'Why does the Wind blow?'

39. **Trade-winds.**—You go on to your second head to teach them further, why it blows in certain *directions*. Keeping still to tropical climates, the trade-winds are your simplest case, being perfectly regular, and easily traced to the same causes as before, with two more added, viz. the fact, that the earth is a sphere, and that it is always turning round on its axis. Here you may be tempted to wish that you had taken the Third Section of the Schedule *first*, that you might have been able to take for granted that the class knew all about the motions of the earth. It seems like *putting the cart before the horse*, to be telling them now the effect of the earth's motions, and some long time afterwards to begin to explain the motions themselves. Perhaps you are right: at least, I do not say that you are wrong. But I *must* go on as we have begun, and so far there is no real difficulty. The children have learnt enough in former years to know what you are speaking of; and under this head, at least, you do not need them to know more than the broad fact, that the earth turns round on its axis from west to east. The point which is really new to them, is the different rate of moving in different latitudes. You must take pains with this, and illustrate it in any way that occurs to you, by globe or ball or carriage-wheel, or anything that will bring out the truth, that, if a whole body *rotates* together, the wider part must move faster than the narrower. When I suggest the carriage-wheel, it is simply to bring out the general principle,

that the rate of moving must be faster, when a greater distance has to be covered. A still better illustration, perhaps, would be to suppose two boys running round a circular path, the one on the inside edge, the other on the outside. *Then* come to the globe, and apply the principle to the motion of the different parts of a sphere. On this the whole theory depends; it is from this that you must show how the current of air from the poles to the equator is turned from due south and north to a south-eastern and north-eastern, and finally to an east wind.

40. So far, with due pains and care, all is easy enough. When you come to the monsoons—*i.e.* winds that are not constant, but periodical—I admit that there is real difficulty. You *cannot* explain these to children who do not know more about the seasons, and the yearly motion of the earth, than they would learn in 'Standard II.' What is to be done? Shall I miss them? Or slur over them, with technical terms without explanation? Or stop to explain the yearly motion first? No! none of the three! The first would leave a blot on your work. The second is our old friend *Cram.* For the third, you have not time. Let us see if we cannot find some middle course. What is it that you really want? You want to bring out the reason why in certain seas—specially in the Indian Ocean—the wind 'blows regularly six months in one direction, and six months in another.'[1] This arises, as no doubt you know, from 'the unequal heating of the neighbouring continents' in their respective summer and winter; and this again, like all changes of the seasons, from the inclination of the earth's axis and its yearly motion round the sun. To explain the matter fully, therefore, you would have to take three steps in tracing effects to their causes:— First, From the trade-winds to the monsoons; Second, From the monsoons to the unequal heating, varying at different parts of the year; Third, From the varying heating to the varying positions of the earth towards the sun. The first

[1] Guyot, p. 73.

step is easily taken—you can easily show the difference between the constant and the periodical currents. The third *cannot* be taken now. But you may take the second: you can tell the class that, when it is summer in South Africa, it is winter in India and Persia, and that six months later the seasons are reversed. Then show, for each season separately, how exactly the principle of the trade-winds applies, causing for half the year the north-east, for the other half the south-west, *monsoon*. This explanation, if well given, will be quite complete as far as it goes. You need not, unless you choose, raise the question, *why* summer and winter are thus interchanged. But, if you have an intelligent class to deal with, it may be well to give them a general notion of the cause, reserving the full explanation till the proper time.

41. **Variable Winds.**—Now, as to the variable winds of temperate climates—the wind of which it is said that it 'bloweth as it listeth,' which 'blows irregularly, without a well-established rule.'[1] You cannot attempt to explain these. The text-books will give you a good many guesses and partial solutions of problems: every year is adding something to our knowledge. But, as it stands at present, it is not full enough or clear enough for children's lessons. Tell them so frankly! Show them that the chief reason of this want of regularity is the greater proportion of land, and its broken surface, its mountain-chains and so on; all which 'disturb the currents, and thus almost every district has its temporary winds, varying in direction, force, and duration.'[2] Yet impress on them that all this seeming confusion is only *seeming*. Nature is orderly in all her working: it is our short-sightedness that cannot all at once see through her plans, or trace her order. We are finding it out by degrees and slowly: to some future generation, perhaps, all will be as plain as the theory of the trade-winds is to us now.[3]

[1] Guyot, p. 74. [2] Page's *Advanced Text-book*, § 221.
[3] See Guyot, chap. ix. §§ 7, 8.

42. **Storms.**—Before leaving the subject of wind, it will be natural to say something about *Storms*. But you will find in all the text-books that they *describe*, but do not attempt to *explain*. This makes your course easy. Get hold of some good description of a *hurricane*, a *cyclone*, a *typhoon*—many names for substantially the same thing: describe one to your class as vividly as you can, and then out of the description gather the leading marks of a true cyclone.[1] It will be a pleasant change, I should think, both for you and your scholars, to be free for one lesson to dwell on striking facts and interesting stories, without attempting to get behind the facts to the exact reason why. If any over-curious mind among them presses for the '*Why*,' you have your old safe refuge to fall back upon. Do not be afraid or ashamed of it. Science, in the present state of knowledge, will bear you out in the confession, '*I don't know*.'

43. **Causes of Rain.**—We come back to the rain-cloud and the rain. We have seen how the clouds are formed; and we have said that they come down in rain, when condensed by cold. Now, how came they to be condensed? The reason is generally change of place,—passing from a warmer to a colder region. And this, as we said before, is caused by wind. The leading principle is thus briefly and clearly stated:—'A warm and moist wind comes in contact with colder air; its temperature is lowered; it can no longer contain so great a quantity of vapour. A portion of its moisture is immediately condensed into clouds, and falls as rain.'[2] Where the wind is regular, the rainfall is periodical; where the wind is variable, rain falls at uncertain intervals. The first belongs to *tropical*, the second to *temperate* climates.

44. You cannot have a better account of the former than that of Guyot.[3] There are two or three little *gaps* in the description—easy steps left out, of which children

[1] See Ansted, p. 260. [2] Guyot, p. 79.
[3] *Earth and Man*, ch. x. §§ 2, 3.

may have to be reminded. When these are filled up, you have the main principles, and you need not stop for exceptional cases. You have enough to point the great difference between these climates and those of the temperate zones. *We* mark our seasons by heat and cold; to those who live in the tropics, though they have some differences of temperature at different times, the main distinction is between the *rainy* and the *dry season.* Tropical rain, as you will find in all the text-books, may be illustrated by figures, showing the enormous amount of rain that falls in a short time. I do not myself think these figures of much value for young beginners, and it would spend some precious time to make them understand what is meant by a rainfall of so many inches in a year. A more telling illustration, because based on a well-known fact, is the effect of these rains in helping to cause the overflowing of the Nile. This, indeed, would form a very good supplementary or introductory lesson—whichever you liked best—leading your class on from the plain fact, and showing them at last, by a kind of surprise, how the plain fact is traced up to the higher principle. The lesson would tell for more than its direct teaching. It would be an example of the practical bearing of all true science, and might help them to believe that these hard words and difficult thoughts have really some useful end.

45. **Return Wind.**—The variable rains of temperate climates are of course, like the winds, beyond the reach of exact rules. The first fact that meets you is, however, definite enough; the west and south-west winds are those which bring most rain; the east wind is comparatively dry. Why is this? In answering this question you will at the same time answer another: Since wind, as we have seen, is a current of air flowing from a colder region to a warmer, how comes it that *warm* W. and S.W. winds blow towards the cold north? Read carefully Guyot's account of the 'Upper or Return

Trade-wind,'[1] and you will find the answer you want. While cold winds are rushing southward to fill the places of the heated air of the tropics, as it ascends, this heated air in its turn presses on the higher atmosphere, and so an opposite current sets in the upper regions from the equator towards the poles, which falls as it cools and forms the S.W. winds of temperate climates. These, though cool compared with tropical heat, are still warm by comparison with the temperature of Europe.

46. **Mountains.**—Now trace the progress of these winds as the chief rain-bearers. Picture them as they sweep across the oceans, both Pacific and Atlantic, till they strike upon the mountain-chains near the western coasts of Europe and America. The class knows of course what a mountain is; you have now to show them the work of mountains as the great condensers. I need not dwell on this; there is no difficulty. All that is needed is care and patience to bring out clearly how the moisture-laden stream of air is forced upward by the mountain-barrier till it reaches a colder level, where it is rapidly turned into cloud and mist and rain and snow. Illustrations of course abound. But it will be best to keep to Great Britain—you cannot have a better example; the comparison of the two sides of the island brings out with singular clearness the condensing effect of mountain-chains. Either the Northern Range or the Cotswolds will furnish a grand illustration; and it brings the matter home in a way that you could never do by reference to the Andes or the Apennines or the Ghauts. If you live in a hill-country, make the most of your local advantages; if you can, and choose to face the weather, take your boys up to the hills on a rainy day, and let them see for themselves something of the course of the clouds. If you are in a town or in flat country, try to bring the scene before them by description or drawing till they *feel* as well as understand the difference

[1] *Earth and Man*, ch. ix. §§ 5-7.

between the *windward* and the *leeward* sides of a mountain.

47. **Evaporation.**—One more subject, and the First Year's course is finished. We have traced the rivers from their mouths to the springs, from the springs to the clouds, from the clouds to the invisible vapour suspended in the air. Now, where did that vapour come from? And how did it come there? The answer, in one long word, is by Evaporation—that is, by that remarkable power of the air of sucking up a certain quantity of water and carrying it about with it in the form of vapour. I call it a remarkable power, because it is in itself so simple, and yet so much depends on it, and all the more so because of its limitations: the air can never carry more than a certain quantity, and the quantity it can carry depends entirely on its temperature. As it grows hotter, it can take more: when it begins to cool, it ceases to absorb. It is not too much to say that on these simple laws hangs the whole course of Nature, so far as regards life in all its forms. But for this power, so ordered and so limited, there would either be no moisture in the air, or the air would go on absorbing all and parting with none, till the land was utterly parched and dried up. But on this subject I need not enlarge. For clear explanation and homely illustration, I have simply to refer you to Professor Huxley's chapter on Evaporation,[1] in which you will find all you need, with some other matters which for your present purpose you need not touch upon. Use his illustrations: I do not think you can improve upon them.

48. That the ocean is, in his words, 'the great caldron, whence the heat of the sun distils the vapour,' follows from the fact that it contains such an enormous proportion of all the moisture on the face of the earth. From every sheet of water, large or small, from every marsh, bog, fen, or piece of

[1] *Physiography*, ch. v.

undrained land, vapour is continually drunk in by the thirsty air. But all the rest is as nothing, compared to the great reservoir in the ocean. So we end as we began: we might have begun at any point, and the circuit we have made in words is the real circuit of every drop of water.

CHAPTER IV.

THE OCEAN.

49. In beginning the Second Year's course your first thought may naturally be, 'How much simpler and easier this will be than last year's!' And you are right. It *is* simpler, in the strict sense of the word; it is all about one thing: and it is easier, because it keeps closer to the facts of general geography, and needs less help from other sciences. Indeed, if you have now to teach both a Fifth Standard, who have gone through the First Section, and a Fourth, who are only beginning the subject, you may take them all together without fear; and I think you will find that this year's Fourth will be better prepared for examination than the others were on Rivers, Springs, Wind, and Rain. Yet, as you will soon see, it is not so easy as it looks. You will have quite enough to do; and, just because there is not much ground to go over, the class will be expected to know each point very fully, and to have mastered all details very exactly.

50. **Extent.**—'The Ocean, its *Extent.*' .Observe, *ocean*, not *oceans*. This points your attention at the outset to the fact that there is really but one vast body of salt water. No doubt your scholars know this. But it will be well to remind them of it, and specially to show them that there is an unbroken sheet of water in the place where they might think there was none—in the Arctic regions, to the north of Asia and America. Show them that, though blocked by ice, there is a passage both ways from Behring's Straits; so that, if

the ice were melted, we should see America on the one hand, and Europe, Asia, and Africa on the other, to be two great islands, with the ocean flowing round them on all sides. As you are not required by the programme set down for you to go into the subject of *Ice*, you will not have to come back to Arctic voyages. You might, therefore, give a glance at them in passing, and illustrate the nature of that ice-bound ocean by any anecdotes or descriptions you have picked up about Franklin or McClintock, or any other of the Arctic explorers. Such illustrations will not only enliven your lessons, but make them more *real.*

51. This being made clear, go on to the figures, giving the extent in square miles. Here, you can hardly go wrong. Any of the text-books will supply the figures. But try, by any means that may occur to you, to make sure that they convey some clear meaning to the minds of the children. It is by no means certain that they, or the duller ones among them, will take in any distinct meaning at all. 'A square mile' is in itself simple enough. But what notion do they form of so many millions of square miles as the area or extent of a body of water or a mass of land of irregular shape, and broken up into countless fragmentary parts? Spend a little time on this, beginning with the square, then the rectangle, the parallelogram, and so on, till you come to curved and irregular outlines; showing them, *not* how you find the areas—that would be Geometry or Mensuration—but what you mean when you say that the area is so many square miles, that is, that the whole extent of the space covered is the same as that of a square of a certain size. IF they happen to have learnt the square root—which, however, will not often be the case—you can make the matter still plainer.

52. **Divisions.**—These illustrations will bring you naturally to the separate oceans—the five parts of the great body of water, to which distinct names are given. You can have no difficulty in defining their boundaries, and the text-

books will give you the length, breadth, and area of each. All this should be got up by home lessons. Then come matters of greater interest, the distinctive characters of each ocean, and especially of the two of greatest importance, the Pacific and Atlantic.

53. At this point you might naturally ask once more, How does all this differ from general Geography? It seems to be very like it, much more like it than what we were dealing with in the first section. True; it is not only very like it, but you may make it to be the very same thing. All depends on how you handle it. The bare facts are commonplace enough. But then, while you are giving these facts, you are all the time looking forward to what is to follow. *You* know, though the children do not yet know, how the mere shape and size of each ocean, its connection with the others, the number and position of its islands, the form and nature of its coasts, affect its currents, its climates, its prevailing winds, and so its influence on the well-being of Man. Hints of what you have in reserve will be easily slipped in, to show that you have not forgotten the higher aims of Physical Geography.

54. **Pacific and Atlantic.**—With these thoughts in your mind, you will find no lack of interest in tracing the outlines of the Pacific and the Atlantic. Read carefully the descriptions in Ansted[1] and Guyot,[2] or in similar works. You will find there, especially in the latter, some views which you will not venture to put before your class. But along with these you will find much that will interest them, and help them to see that the ocean is something more than a dull expanse of water, without variety, except the tossing of its waves.

55. A special hour may well be devoted to the *contrasts* between the two oceans, especially that which is expressed

[1] *Physical Geography*, chap. vii. pp. 131-136.

[2] *Earth and Man*, chap. v. §§ 1-3.

by the word *canal*, applied to the Atlantic. This contrast is thus expressed: 'The Pacific is broad, open, and uninterrupted; the Atlantic is comparatively narrow and shut in.' It is the more necessary to dwell upon this, because no ordinary map enables you to put the two, side by side, before the eyes of the children. That in hemispheres cuts the Atlantic into two halves, placed back to back. Mercator's, though better, is not perfect for this purpose. On a globe, of course, they can see each exactly as it is, but not in one view. You must take pains to show them first the one and then the other, or draw outlines of each, side by side, on the black board, till they take in clearly their very different shapes and sizes.

56. **Bed of the Ocean.**—So far you have dealt with the ocean, as you see it on the top, or as it looks on the map, as if it were merely a flat surface, covering so many square miles, bounded by coasts, and cut up by islands and other pieces of land into different parts. You have now to look below the surface. 'Yes,' you will say, 'to the depth. I know all about that. The Atlantic has an average depth of so much, the Pacific of so much,' and so on. No! not yet at least. It may be well at last to give some figures of averages, and *maxima* and *minima*. But let us go gently. There is an intermediate step, before we come to the actual depth, as measured in feet. Read carefully what is said about *basins* and *saucers* in the ocean,[1] and especially think over what is meant by the expression, *even where the connecting banks and submarine ridges fail to reach the surface*. This brings before you quite a different picture, of ridges and banks, and hills and mountains, and valleys and plains, below the level sheet of water which we see. It bids you look in thought a little way down, and tells you that you will find some of these hills or ridges very near to the surface, sometimes detached, sometimes sloping downwards from the end

[1] Ansted, p. 134.

of some hill or mountain on land. So that if you imagine for a moment all the water drained off, you would then have the great bed laid bare, divided by these *submarine* or *under-water* ridges into so many separate hollows. *Turn on the water*; and then, as it rises to its present level, you will see (in thought) these hollows filling by degrees, then one and another of the ridges covered, till all are hid from view, except a few of the highest, which stand out from the water, and receive the name of Islands. A little less water, and you would have many more islands, the tops of many more ridges would be uncovered. A little more water, and many islands would disappear.

57. Have you got this clearly into your mind? Then try to make it clear to your class. Your best illustration, if you could have it, would be by making a mimic ocean in ground that will not let water run through it at once, or (if you prefer it) make a little model in clay: make the dry bed first, divide it by ridges, and then let the water flow into it and over it, till you get a model of the ocean as it is, with one or two *peaks* and *tablelands* projecting above the surface. You may add one other thought. I do not advise you to make too much of it; but it would fix this picture in their memories, if you were to tell them that *very likely*, long, long ago, this bed of the ocean, or great part of it, was really dry, while what we call *land* was covered with water. Ask them if they see any difficulty; and try if you cannot work out from themselves that either our land must have been much lower, or the bed of the sea much higher, or both. When they have once worked out this thought, they will not soon forget the ridges and basins of the ocean.

58. You need not, I think, attempt to go much into detail about particular *basins* or *saucers*. As to the Pacific, master the outline as given by Ansted,[1] and teach it clearly and briefly in a single lesson.

[1] Pp. 134, 135.

59. **Atlantic.**—The Atlantic needs more attention. Just as I advised you, in treating of rivers and river-basins, to follow closely the courses of one or two rivers, so I advise you now to keep from this point almost entirely to a single ocean, and that one the Atlantic. I need hardly say why. It is the most important, it concerns ourselves most nearly, and we know most about it. This has always been true; but it is most of all true at the present moment. You know, perhaps, that, a few years ago, a ship called the *Challenger* was sent out, with a number of scientific men on board, for the purpose of exploring every part of the ocean, sounding to find its depth, examining its currents, and trying to find out as much as possible about it. That ship finished its cruise some time ago. But it takes a good while to work up so many facts and figures so as to see what they teach, and still longer to put it all in such a form that people may understand it. So, all that has yet been published is the account of the Atlantic: more will come in due time. Meanwhile, we know, much more exactly than we did, what the Atlantic Ocean really is.

60. **Voyage of the 'Challenger.'**—I should be glad to think that most of you had read Sir Wyville Thomson's book.[1] But, as I fear it is not likely to be in your hands, I will break my usual custom; and, instead of referring you to passages or chapters, I will give you a few brief extracts, slightly altered in expression, to suit my purpose. As to the form, or what he calls the *contour* of the Atlantic, these are his 'General Conclusions':—

'An elevated ridge, rising to an average height of about 1,900 fathoms below the surface, traverses the basins of the North and South Atlantic in a meridional direction'—that is, nearly due north and south —'from Cape Farewell, probably as far south at least as Gough Island, following roughly the outlines of the coasts of the Old and New Worlds. A branch of this elevation strikes off to the south-westward,

[1] *Voyage of the 'Challenger.'* The Atlantic.

about the parallel of 10° N., and connects it with the coast of America at Cape Orange; and another branch crosses the eastern trough'—that is, the basis on the east side of the main or 'axial' ridge—'joining the continent of Africa, probably about the parallel of 25° S. The Atlantic Ocean is thus divided by the axial ridge and its branches into three basins: an eastern, which extends from the west of Ireland nearly to the Cape of Good Hope, with an average depth along the middle line of 2,500 fathoms; a north-western basin, occupying the great eastern bight of the American continent, with an average depth of 3,000 fathoms; and a gulf running up the coast of South America as far as Cape Orange, and open to the southward, with a mean or average depth of 3,000 fathoms.'[1]

The mean depth of the whole Atlantic, *including* the ridges, he gives as 'a little over 2,000 fathoms.' I give you this in full, because it is both clearer and more exact than any which you will find in the common text-books. Study it with a good map. Draw a skeleton-map, accurately to scale, with parallels and meridians marked. Fill in these ridges according to his description. You will then have a fairly true chart of the *land below the sea*. Reproduce this to the class: it will be *perfectly* correct as far as it goes, so far as we know from the most recent and most thorough examination.

61. We return to the surface. There is much that is extremely interesting in the account of the bottom of the ocean, the shells and other deposits brought up from it, and the means employed for sounding and dredging at such depths. But you are not required to go into this. Having taught so much of the ocean, as if it were always still, you have now to go on to speak of it in *motion*. Its movements, as you know, are of two kinds—*currents* and *waves*. *Currents* come naturally first; they keep you chiefly in mid-ocean, while *waves* will bring you back to land.

62. **Currents.**—What, then, is a *Current?* Are you sure that you know? Be very exact; and remember that

[1] *Voyage of the 'Challenger,'* vol. ii. ch. v. pp. 290, 291.

you will have, by-and-by, to show how it differs from a wave. A current, then, is simply a stream, a movement either on or under the surface of the ocean, like the flow of the river on land, in which the *same* water passes on from point to point. We have to deal just now with those on the surface. Your course here should, I think, be very much the same as that in which I have tried to guide you in teaching the extent and depth; that is, *first*, explain generally, by examples more than by definition, the nature and causes of currents; take your examples at first from different parts of the world, and come at last to the greatest of all, the Equatorial Current of the Atlantic, and its sequel, the Gulf Stream.

63. The chief cause of these currents is, in one word, Wind. Variable winds make changing and uncertain currents: permanent winds make constant currents. Other causes, such as difference of temperature, the rotation of the earth, the position of islands, &c., affect them, turn their course, alter their speed, and so on. Indeed, every cause which affects the movements of the air, affects also the movements of the water. But of permanent currents at least it may be said that they are due, almost entirely, to wind. Illustrate this a little by examples, and then turn to the equatorial westward current. I need not go over *with you* what we said in the first section about wind. But you will have to go over it with your class, and should indeed be glad of so good an opening for revisal of former work. When once they know that wind causes currents, they ought to be able to tell for themselves where we may expect to find the most striking constant current. Work this out patiently. If last year's teaching was successful, they ought to be able to remember the account you gave them of the Trade-winds; and, remembering this, it should be easy to follow it out to its natural consequence, the stream of warm water flowing westward from the coast of Africa to the Gulf of Mexico. For an exact account of this great current, I give you

another extract from Sir Wyville Thomson,[1] abridged to suit my limits.

This 'Equatorial current, impinging upon the coast of South America about Cape St. Roque, splits in two; a considerable portion of the northern branch coursing round the Gulf of Mexico, and becoming contracted and condensed by the Strait of Florida . . . . while the remainder, moving outside the islands, spreads over the bight between North and South America, and is felt all round the Bermudas. . . . The branch deflected to the southward of Cape St. Roque passes down as the Brazil current, parallel with the coast of South America. . . . It is at length almost entirely merged in the great easterly drift-current, which sweeps round the world in the southern sea. But it is not entirely lost; for, . . . opposite the point where this deflection occurs, there is comparatively open sea far to the southward, and a penetrable notch in the southern pack.' That is, the warm water from the Equatorial current has at this point prevented the ice of the Antarctic Ocean from reaching so far north as in other parts.

I have given you the latter part of this extract to complete the account of the Equatorial current. But you need not say much about this 'easterly drift-current.' Sir W. Thomson himself says that 'the cause of it is somewhat obscure'; and if he does not understand it, *we* may be content to leave it alone. Only make clear this twofold or threefold division of the current:—the northern branch, in two parts, which you may call the inside and the outside, separated by the West India Islands; and the southern, running into the easterly current in the southern sea.

64. Our chief concern is with the *inside* portion of the northern branch; because it is from this that the *Gulf Stream* takes its rise. Of this very important current you will find descriptions in all the text-books. See especially that in Huxley.[2] You will see that he there expresses a doubt, whether the true Gulf Stream really reaches our shores. As it is not desirable for you to speak doubtfully on such a point if you can help it, I am glad to be able to

[1] *Voyage of the 'Challenger,'* vol. ii. ch. v. pp. 312, 313.
[2] *Physiography*, ch. xi. pp. 173-176.

give you a distinct opinion from the very highest authority, Sir W. Thomson.

'It seems to be generally admitted that the Gulf Stream is due to the reflux of the Equatorial current'—that is, the westerly stream is turned by the coast of America, and becomes a north-easterly current towards the northern shores of Europe. . . . 'Most physical geographers seem to be at one as to the very important influence which it exerts in distributing and accumulating tropical warmth in the North Atlantic, and in ameliorating the climatic condition of the countries which border its northern shores.'[1]

Put this into rather simpler words—Sir W. Thomson was not writing for children—and you have the substance of what you have to teach.

65. One other interesting fact should be noted—the *shallowness* of the Gulf Stream, that is, that the warm water and the current go but a very little way down; and, below that, the water is as cold as in other parts of the ocean.[2] Once more I quote Sir W. Thomson.[3]

'The Gulf Stream was, early in May 1873, at the point where we crossed it, about sixty miles in width, and 100 fathoms deep.'

The figures would differ a little at different times and places; but these are enough for your purpose.

66. So far, your way has been easy. Before leaving the Atlantic currents, however, you must let the children understand that there are many more, besides these chief ones on which you have spent so much time. Just as the form of the American coast, and the position of the islands, turn the main Equatorial current with one great bend, so there are various other turns from similar causes, producing a great number of *branches* and *counter-currents* in various directions. The most marked, and that which you may take as an example, is 'the tolerably constant current to the eastward called the Equatorial counter-current,' which 'occupies a portion of the ever-varying space between the north-east and the

[1] Vol. i. ch. v. p. 390. [2] Huxley, p. 176. [3] Vol. i. p. 371.

south-east trade-winds,[1] and which, when joined by a portion of the southern influx of the Gulf Stream, is called the 'Guinea current.' Of this, also, Sir W. Thomson says, 'Its causes are not well known.' It is worth mentioning, to prevent the class from fancying that all is still in the Atlantic, outside the 60 miles of the great current. But it is not worth dwelling on long. If our old friend, the sharp boy, insists on knowing how there comes to be an easterly or south-easterly current, you have high authority for the old answer, 'I don't know.' The farther you get in Science, the more clearly will you see how little man knows, in comparison with what remains to be known.

67. If you have time, you may also note, without dwelling long on it, that there is an equatorial current in the Pacific, produced by the same causes.

68. **Under-currents.**—At this point, the sharp boy may perhaps put in another question, more to the purpose than the last :—If all this body of water is always running away westward, how is its place supplied? The counter or reflex currents give you part, but not the greater part, of the answer. Do not give the rest of it at once. They should find it out. Go back to the theory of wind once more. What caused the land and sea breezes? What caused the 'return wind'? Just so, or at least in a way not unlike this, when the warm water runs off to the surface, its place must be supplied. How? By cold water running in. From what quarter? Plainly from the Poles. And will the cold water run in on the surface or below? And so you get easily to the *under-currents* of cold water, setting from the Poles to the Equator, from the Arctic and Antarctic to the Atlantic and Pacific Oceans. Of these, of course, we do not know so much, because they are out of sight. But a wonderful amount of skill and patience have been shown, and with

[1] *Voyage of the 'Challenger,'* vol. ii. ch. ii. pp. 79, 80.

great and increasing success, in sounding these deep waters, to compel them to give up their secrets.[1]

69. There is one curious fact, which you must not omit. Sir W. Thomson is again the authority. But you will find his statement condensed by Prof. Huxley.[2] We are apt to think of the Antarctic Ocean as being of all portions of the earth's surface that with which we have least to do. If you ask your scholars, from which of the two frozen oceans they suppose most of the cold-water supply comes to the North Atlantic and Pacific, they will say at once, '*From the Arctic.*' Yet it is not so, in all probability. From the unknown and unthought-of Antarctic, where the foot of man (in this age of the world) has never trod, whose waters no ship has ever traversed, comes the main supply which keeps up the circulation of what we may call the *civilised* oceans, and repairs the drain caused by the surface-flow, taken away to warm the northern regions, and make them truly *temperate.*

70. **Waves.**—So much for Currents. Now for *Waves.* Again you have to ask, What is a wave? How does it differ from a current? Look back to your definition. In what point does it not apply to waves? Think over your answer, bearing in mind that you are *not* here to take into account the action of the tides. That is a separate matter. Waves, as waves, are independent of the tidal motion, and (like currents) are caused by wind. For the difference, and the real nature of waves, see Huxley.[3] Nothing could be more clearly or more beautifully put. *For once,* I advise you simply to master his explanation, and give it as it stands,

[1] Any teacher with a taste for Mechanics would find almost the most interesting part of Sir W. Thomson's book in the description of the machinery employed for sounding and dredging; and, if able to reproduce the woodcut illustrations, would be sure of an attentive class for one lesson. See especially vol. v. ch. ix. p. 362.

[2] *Physiography*, ch. xi. p. 178.

[3] Pp. 170, 171.

illustrations included. I do not see that you need any further guidance. But, though I pass over it so briefly, you ought not to be so brief in your teaching. It will need a good deal of explanation; and when you have explained it, this is the very place for a few well-chosen anecdotes to illustrate the force of waves and the dangers of the sea.

71. **Saltness.**—The *saltness* of the ocean is another branch of your subject. I do not advise you to linger long on it. All that is important may be found in any text-book—most accurately, probably, in Huxley.[1] See also Ansted.[2]

72. **Tides.**—We are now almost ready to leave the open sea and approach the shore. Almost, but not quite. We have to speak of *Tides*; and of these we may say that, while the *theory* of them comes out clearest, when looked at in the open ocean, it is close to shore that we seem to know them, and are able to watch their action. You know, I suppose, in a general way, the reason of the tides. You will find it clearly stated in Huxley.[3] And you will see there how it is possible to give a clear explanation of the leading principle, while leaving entirely out of view all secondary details. You must be content to do the same. Remind the class of your early lesson on Gravitation, and then lead them on to the larger principle of Attraction. Give example after example of a simple kind, till you have made them by degrees see that it is universal, but that its force in each case is measured by the *size* and *distance* of each body. All this will give you some trouble; but, when this is done, it will be easy to apply the principle to explain the cause of the tides, why they come, why they are sometimes high, sometimes low, and why the moon, though so much smaller, has more to do with them than the far greater sun.

73. In all this you will find yourself speaking of the tides

[1] Ch. viii. pp. 127, 128. [2] Pp. 138, 139.
[3] Ch. xxi. pp. 373-375.

in the open sea. And your description will put before the class the picture of a *wave* rather than a *current*, only of a wave not due to wind or affected by it, but solely to the attraction of sun and moon. Yet those of them who have ever stood upon the seashore, as the tide came in and out, have seen it rise and fall, or advance and retire—have seen sands covered and then left bare, or have marked on the cliffs the point to which the waters rose, and from which they began to fall. Do not try to hide this contrast. Rather bring it out as sharply as you can. Encourage the children by all means to observe for themselves; and, when what they see does not seem to agree with what they are told, not to distrust either, but be content to wait till in due time all shall be made plain. There is a lesson here of *faith*—faith in the truth they see, faith also in the truth which as yet they cannot see.

74. In partial explanation, take these words as your text: *In the tidal wave in the ocean, the water simply rises and falls, but does not move onwards: in narrow seas it becomes converted into an actual wave of translation*: that is, it does move onwards.[1] Dwell on the words *narrow seas*. It is not difficult to show that narrow seas wash the coast of nearly every part of the British Islands—*every* part indeed, except the western side of Ireland; and so, that onward movement of the tide, to which our eyes are used, is really the exception to the rule, though for us so common that the rule is almost forgotten. There is a story of Hugh Miller's,[2] extracted in some of the school reading-books, which would come in as a capital illustration of *spring* and *neap* tides. It tells you how he and a boy-companion reached a point of sand under the rocks at neap tide, and then found, to their dismay, that they could not get back. Find this story, if you can, and let your class read it while the lessons on the tides are fresh in their minds. They will not soon forget it.

[1] Huxley, p. 180; slightly altered in expression.
[2] *My Schools and Schoolmasters.*

There is also in Scott's 'Redgauntlet' a very vivid description of the rapid rising of the tide in the Solway. With this you may compare a real account of the same thing, in the lately published 'Life of George Moore.'[1] If you happen to be near the sea, especially on a coast such as that of South Wales, abounding in caves and inlets, the class itself might furnish some small histories of adventure.

75. **Indented Coasts.**—*Caves and Inlets!* jutting promontories, sharp projecting rocks, deep bays, narrow gorges! How come they to be there? Why are they plentiful on some coasts, as on that of South Wales, or the west of Ireland; while on others, like Yorkshire or Norfolk, you have a smooth outline, hardly broken by a single indentation? To answer this question fully, or to go minutely into the appearance of any particular coast, you would need to look a little further into Geology. But all you really need is to bring out two leading principles or facts of nature. The first is, the great force of the sea in wearing down any solid body that opposes it. If you live near the sea, this will not cost you much trouble either to explain or to prove. To the children of seafaring fathers, storms at sea are only too well known, and many of them may have had bitter cause to feel the destructive power of the waves. Yet even they may need some help, and inland-bred children will need a great deal of help, before they see clearly what that power is, and how it works. They have been told of three kinds of motion in the sea—currents, waves, tides. Which of these is it that exerts this power to destroy? The child who has never seen the sea may be puzzled, and answer at random. Nay, if he has got up the 'definitions' of these in giant Cram's fashion, without thinking, he might be excused if he fancied that it was the current with its onward march, rather than the wave with its mere rise and fall. The child on a sheltered coast may have watched the inflowing of the tide, but never seen the water

[1] Ch. iii. pp. 40, 41 (small edition).

lashed into foam, or dashing its breakers with fury on the rocks. But bid them watch more closely—let them see how gently the tide advances if there are no crested waves behind it. It should be easy to show that it is the waves that possess this force, a force borrowed from the winds that formed them; and that, though the water itself does not travel onward, the force travels and the wind travels with it, and so the heavy swell raised far out on the ocean comes dashing itself upon the shore. Tides, no doubt, do something towards the effect. When wind and tide agree, that is, when waves are rolling in towards the shore at the same time that the tide is rising, they act with double power. But still keep it clearly in view that the power of the sea is in its wind-blown waves.

76. Now for the unequal effects. Here you may (if you like) get up some of the hardest words with which Science can supply you, and frighten your children with them. But the simple principle needs only two little words—*hard* and *soft*. Some rocks are harder than others: the harder ones stand longer against the ceaseless dash of the waves, while the softer crumble away. So, however strange the forms which meet your eye on the coast—caves, tunnels, uncouth figures, natural bridges, detached rock-islands—they have all arisen from this one simple fact: these are the harder portions, the soft have disappeared.[1]

77. One thought more, and this section closes. You will find it in Huxley.[2] It is simple, but very striking. You might prepare for it, by once more picturing out the scene—or better, if you can, by going to see the real pictures drawn by Nature—of the action of the waves on the cliffs. Draw out now the *difficulties*—show how unlikely it is, after all, that the mere weight of water should do all this. If even your children begin to think that you are unsaying what you said before, never mind. It is the very

[1] For illustration, see Huxley, pp. 108, 109; or Bonney's *Manual of Geology*, ch. v.

[2] Ch. xi. p. 167.

point to which you want to bring them. Now point the question, Is there nothing but water beating against these cliffs? Is there nothing working *in* the water and *with* it? And so, work out Huxley's figure of the 'stone hammers,' as the tools employed by this industrious workman.

78. After all, I have yet *another* last thought! What has become of the fragments, the broken pieces, which the sea has crumbled off the rocks? Let your sharp boy find out the answer. Tell him that some of it has gone out to sea, but (on some beaches at least) a good deal remains. Where is it? Let him think and guess, till he guesses right, that the firm sand under his feet on the shore, or the loose sand above the high-water mark, is the powdered remains of rocks, which the sea has broken off with its hammers, then knocked to pieces and crumbled down, till at last it became sand, and either remained on the beach, or was carried off to form the floor of the sea itself.

79. So you may end this section pretty nearly where you began the first, at the estuary of a river. Take your stand, not exactly at London Bridge, but a few miles farther down, at Reculver.[1] You cannot take leave at a better point. When you have brought out the example there given of 'Denudation'—you may give them the hard word at last—run lightly over the whole history of Water once more, and let them see in one view the wonderful variety of forms and phases through which it passes; working like a living agent in the ocean, strong for destruction, yet ministering to man's wants; then mounting in vapour, floating in cloud, descending in rain; filling the springs, trickling down the mountain-side, swelling into the great river, and so returning again at last to the bosom of the ocean. No beginning, no end! But one ceaseless circuit, and in all these changes no particle really lost! Was it always so? Or must not these changes have had a beginning?

[1] Huxley, p. 170.

CHAPTER V.

THE EARTH AS A PLANET.

80. **Subject.**—It seems curious, in beginning the third and crowning part of your course of lessons, to find yourself engaged with many of the same topics that you talked about, long ago, to the children in the Second Standard. You then tried to make them understand the form and figure of the earth, the daily movement round its axis, causing day and night, and its yearly movement round the sun, as one cause of the changes of the seasons. Does it not seem strange that we are to end where we began—that the last lessons to the most advanced scholars are to be about the very same things that were thought easy enough to set before the little lads near the bottom of the school? Yes, it does seem strange. But it would be more than strange if there were not a broad distinction between the two courses—between the milk which you served out to babes four years ago, and the strong meat which they are now thought able to digest.

81. The distinction is the old one between facts and causes, or in some cases between simply *explaining* the fact and *proving* that it is so. Look back to what I said before. You then told the children that there was much more to be learnt about the earth's figure and motions which they could not then understand, and which would be given to them at some future time. That time has now come; and, as you will soon see, this is an instance of what is not uncommon, that things so simple as to lie on the

threshold of knowledge are due to causes, which it taxes the minds of the deepest thinkers to trace or to explain; just as so common a thing as the little brook, that sparkles by the cottage door, led you down below the rocks, and then up to the clouds, and down again to the ocean, before you had fairly mastered the history of its watery particles!

82. **Difficulties.**—You see, then, that I consider this third section the most difficult part of your work. It is so, because it rests on astronomy; and astronomy, if really understood, rests on advanced mathematics. Your own mathematical knowledge may probably fall short of what is needed; and, even when you see the proof yourself, you may be unable to put it simply enough for children. Yet let us try. I will do my best to guide you in choosing those modes of proof which are mathematically sound, and yet such as you may hope to put in a simple form. *You* must do your best to follow my guidance, and to resist the temptation to cut matters short by some summary process of our old enemy giant Cram.

83. **Questions to be answered.**—*First*, try to have clearly in the children's minds the questions which have to be answered—the facts you are to account for. Picture out for them a scene, bringing all into one view. Suppose you are standing on rising ground, with a plain below you, and the sea a little way off. You look round, and on all sides you have an apparently flat surface, cutting the sky in a circle called the *horizon*. Above you is the sky, looking like a great *concave hemisphere*. Across that sphere the sun is steadily moving from east to west. Night comes on, and you lose sight of him; and in his place you have the moon and stars, moving in the same direction, most of the stars keeping the same places among themselves, while the moon seems to travel through them from west to east. This is all perhaps that one day and night would show you; but watch night after night, and you will find out that

there are a few stars which do *not* keep the same places, but seem to wander about, though moving in the same general direction, and so are called *planets* or wanderers. Watch day after day and night after night for a whole year, and you will find out further that different stars are seen at different times of the year, and that the sun moves differently at different times; rising higher and shining longer at what we call summer.[1] Here, then, are four questions:—

(1) Is the surface of the earth flat? Or, if not, how do you know that it is curved or rounded? And, if rounded, how are you sure that its figure is a sphere or spheroid?

(2) Do those heavenly bodies really move round the earth in about twenty-four hours? Or, if not, why do they appear to do so?

(3) Why do most of the stars keep the same places, both among themselves and to observers at different places on the earth's surface? And why do the sun, moon, and planets change their places?

(4) Why are there these differences of *seasons?*

There are many other questions to be answered, if you were learning or teaching *astronomy*. But you have only to do with those which affect the earth: the laws of the stars concern you, only when they make some difference to the state of things on the earth. Even of those which I have here set down, one at least it will not be necessary for you to answer fully.

84. **Distance of the Stars.**—After saying this, you may be surprised if I say next, that the *third* of

[1] See Moseley's *Lectures on Astronomy*, § 12 (J. W. Parker, 1854). I do not know whether this book is out of print; if not, it will repay your study, though of course you will bear in mind that twenty-five years is long enough for any book on this subject to become a little out of date.

these questions is that which I advise you to take first. It *seems*, of all the four, to have least to do with the earth. The reason for this choice will appear presently: it is convenient, in answering the first question, to have settled beforehand one leading fact about the fixed stars—their great distance from us. For this is the answer: The fixed stars do not appear to change their places, because they are so far off; the sun, moon, and planets do appear to change, because they are so much nearer. That this is so, is readily proved without going to mathematics for the proof. Nothing can be easier than to show, by simple illustration, that objects seem to change their positions in regard to each other, when the person who is watching them moves from one place to another. Lights on shore to a person sailing by is as good an example as any.[1] If you live near a coast where there is more than one lighthouse, and any of your scholars are the children of pilots or fishermen, you may get from them—or they may get from their fathers—how the lights sometimes seem to be in a straight line, and then *open* as the vessel advances, and seem every moment to be changing their places. But you can choose your own: there are hundreds to choose from. And, without really bringing in any ideas taken from mathematics, it will help to make all clear to draw a simple diagram on the black board, showing how, if a person at C sees two objects at the points A and B, and if he then moves to D, A and B will seem to have got into a different position; so that i he did not know that he had moved, he would think that one or both of these objects must have done so.

85. Now, suppose the boat to be withdrawn farther from the shore. What will be the effect? A very little thought will show that, the greater the distance between the observer and the objects, the less will they appear to move as he changes his place. This is easily shown on your diagram; still more easily, perhaps, and quite as effectually, by looking

[1] See Moseley's *Lectures*, § 1.

out of a window, or from the school-room door, and trying the effect of moving about, first on two objects close at hand, and then on two others farther off.

86. This being so, it is not hard to see that, if the distance is very great indeed, our changes of place would have no effect at all on the apparent position of the objects: move as we would, they would be seen just as they were at first. So that, when we find bodies like the stars remain 'fixed,' *i.e.* at the same apparent distance and direction from each other, however we may move about, 'it follows, with the most certain evidence, that these stars are immensely distant from us.'[1] I do not see any difficulty in making this clear to an intelligent class. A single question should then be sufficient to complete this part of the subject: *Why do the sun, moon, and planets change their places?* If the answer is not forthcoming at once, there has been something faulty in your explanations.[2]

87. **Figure of the Earth.**—We can now return to the question of the figure of the earth. Here you will find that the easy proofs which you gave to the Second Standard are still available: they are accepted as good proofs in scientific treatises. Such are the fact that ships have sailed on and on in the same direction, east or west, and have come back to the same point; or, again, the fact that if you watch a ship sailing away from harbour, you lose sight of the hull, while the top-sails are still in view. 'Well,' you may say, 'I went through all this before; what more can I say?' Let us see. The proofs are good, *so far as they go.* But what have you proved? By the first it is made perfectly certain that the earth is not a flat surface—that a voyage can be made

[1] Moseley's *Lectures*, p. 4.

[2] I do not use, because I do not wish you to use, the hard word *Parallax*, which denotes these apparent changes of place. But you will need it, if you go far into the subject.

round it on a line returning into itself, and that therefore its surface, *from east to west*, is curved. But you have not yet proved that the curve is a circle, nor that it is also curved from north to south. Even if the curve be a circle, the form of the earth might be a cylinder! The second mode of proof takes you a little farther; for you can certainly show that the earth's surface is curved in every direction, which brings you a good deal nearer to showing that it is a sphere. Add to what can be seen by the common observer, *one* scientific fact—that *the convexity is everywhere very nearly the same* [1]—and your proof is really complete.

88. In this last paragraph I have tried to bring out distinctly how your present teaching ought to differ from the elementary lessons of four years ago. It is not now enough to give a partial proof, which is good as far as it goes; you must show, step by step, what each proof is worth, and what more is needed. Take up the voyage round the world; refer to Magellan as the first who proved it possible; mention, if you like, in passing, how Columbus by thought and reasoning had satisfied himself that the world was round, and set out in the hope of reaching India on the other side of the Atlantic. Then draw from the children, if you can, how much this proves, and what is wanting; impressing on them, at the same time, how great a step forward it was to have found out so much. It seems to us now absurd and childish to think that the surface of the earth is flat. Yet wise and thoughtful men for ages believed it. So the world grows wiser as it grows older. One great man strikes out a thought, another great man proves it true; and then we little people who come afterwards borrow their wisdom, and are apt to think ourselves wiser than they! Yet the wise men were they who groped after knowledge in the dark and found it, and then lit up the dark places for those who followed them.

89. The proof from the ship is very simple, and is found

[1] See Huxley, ch. xix.

in nearly every text-book. For good illustrations see the figures in Huxley (pp. 318, 319). Copy the second, if you can; but do not forget to point out that the sea is not really *so much* rounded as it looks in the picture: the farthest ship must be a good deal farther off than it appears to be. All this is easy enough. It will cost you more pains to put into simple words the hard words printed in italics at the end of § 87. But the distinction is really not hard. A circle, as you can easily show the class, is equally rounded in every part: an ellipse, or any other curved figure, is more rounded in one part than another. Now, every curve which goes round a sphere is a circle; so that every part of its surface is equally rounded; while any other solid would show more rounding in one part than another. With care, and a little skill in the way of putting things, you may make this plain, and it will clear your way for what is to come after.

90. Another illustration, which comes to the same point, is that from the roundness of the horizon, and the widening of the circle as the observer climbs higher.[1] This has the advantage of being within the knowledge of all children, wherever the school may stand: you can anywhere show the round 'circle of vision, which seems to separate the sky from the earth'; and, almost everywhere, there is some rising ground high enough to show how that circle widens. I should, therefore, put this forward sooner than the ship, except in places near the coast. And the last step is more easily taken in this form: it is easier of the two for children to understand, if put in plain words, that 'the horizon is invariably circular,' than that 'the convexity is everywhere nearly the same.'[2] That is, it is easy to let them see that, looking round them as far as they can in the open air, the line where sky and earth seem to meet is always a circle, and that this is true everywhere; while it is rather hard to

[1] Huxley, pp. 320-322. [2] Ibid.

make plain to them that the surface of the earth is equally rounded on every part of it.

91. There is yet another proof, which is worth mentioning, and which illustrates the way in which our knowledge of the distances of the fixed stars can be made to bear on questions about the shape of our own earth.[1] You will find it in Huxley (pp. 323, 324), and also, in more mathematical language, in Moseley (pp. 13–18). The latter statement is the more complete, and I think it may be put into a form in which children might understand it. The Polar Star is well known, and appears to us at a certain height above the horizon. If we travel due southward, then night after night (for a time) we shall still see the star, but each night lower down, till at last a night comes, when it seems to touch the sea, and the next night we do not see it at all. Now why is this? The star has not moved; for, if we had stayed at home, we should have seen it, just as at first. Nor is it merely because we have changed our place. For, if we had been travelling on a flat surface, the star is at such a distance from us that our change of place could not have made any difference in its apparent height.[2] Therefore it follows—and this is as certain as any proposition of Euclid—that the reason why the star apparently changes its place is because the earth's surface is not flat but curved, and therefore its horizon is constantly changing its direction.[3] Nothing else could account for the appearance. So that, strange as it may appear, we look to the distant star, just *because* it is so distant, to settle for us what is the shape of the earth on which we tread! If it were not so far off, it would give us less help.

[1] See § 86.

[2] I have put this into the plainest words I could find. Stated mathematically, the form of it is, that, the star being (practically) at an infinite distance, the difference of the angles of any two observations would be imperceptible, if the traveller moved on a plane surface. See Moseley, p. 15.

[3] See Moseley, p. 16.

92. Now, to see if your class have taken it all in, ask them if they can find any flaw or defect in this proof. If not, go over it again. Sooner or later, it will strike them that you have proved the curvature north and south, but not east and west; so that you might here have the cylinder again, only turned the other way! This is not quite true: the observations really take you much nearer to proving that the shape is that of a sphere, and can be nothing else. But you need not insist on this. Bring in again our first proof, and all is perfect: the Polar Star tells us of the rounding north and south, while the voyage round the world proves that from east to west.[1]

93. In all this I have taken for granted that the earth is an exact sphere. It is better to do so in the first instance, as it makes the reasoning so much simpler. In point of fact, all the observations agree in telling us that it is very nearly so, but not quite exactly. It is slightly more curved at the equator than the poles; and this, of course, is well known to the class, by the familiar illustration of the orange.

94. Now gather up what you have been teaching into one view. The voyage round the world—the view of the out-bound ship—the circular horizon—the changing appearance of the Polar Star—each of these is complete in itself, and, taken together, they fairly prove our point, that the earth is not a flat surface, nor a cylinder, nor a cube, but a spheroid, and very nearly a sphere. Give a revisal lesson, or (if necessary) lessons, on these four proofs, and do not leave them till you feel sure that the class really sees their force, and *how* they bear on the fact to be proved. Keep in mind also, that the strength of the proof rests on the further fact that no other theory has been, or (we may venture to say) can be, put forward, which will account for the facts

[1] See also Huxley, p. 324. But I do not suggest the use of his additional proof, because it seems to bring in the rotation of the earth on its axis, with which we are not yet concerned.

observed. Do not fancy that such close reasoning is beyond the children. Children can follow reasoning well enough, if it is properly brought out in simple words; and the practice in following it is not the least of the benefits of lessons on such subjects. Let the teacher be clear, lively, and patient; and the answering on examination will be intelligent and thoughtful. If the teacher *crams* up his own information, and loads his lessons with hard words, I leave you to guess what sort of answers the Inspector will get at last.

95. **Size of the Earth.**—We go on to the *size* of the earth; and again the question arises, Shall I be content to give the figures? Or shall I try to let the class see how these figures are obtained? On this point, I should find no great fault with you if you simply gave the figures, and went on. But it may be worth while to try once more to *prove* your point. Here, then, is the clearest proof I can find; or, rather, it is an outline of the proof, taking for granted some steps, which are strictly geometrical.[1] It is assumed that the earth is a real sphere; which is so nearly true, that the error makes very little difference to the result. Fix your eyes once more on a fixed star. It is found that, if we move from one place to another on the earth's surface, for every degree[2] we travel, the star appears to rise or sink one degree; that is, to be so much higher or lower, as measured from our horizon. So, when we want to know how far we have gone, we measure the rising or sinking of the star: when it has risen or sunk a degree we know that we have travelled a degree. It is, then, quite easy to measure the *distance* we have travelled; and

[1] See Moseley, § iv. p. 19.

[2] It will be necessary to make sure that the children understand, or (if they do not understand) to explain to them, how the circumference of a circle is divided into 360 *degrees*, and how these degrees are measured by the angles opening upon them from the centre. This is easily done by a figure on the black board.

this is found to be (very nearly) 69½ miles.[1] This we take as the length of a degree; multiply this by 360, and the children can tell you that the circumference is (nearly) 25,000 miles. Knowing the circumference, we know how to find the diameter; and this must be (nearly) 8,000 miles; or, speaking roughly in round numbers, the earth 'is a great ball, about 25,000 miles round, and 8,000 in diameter.' Is there anything too hard in this? I think not. Keep clear of *sham*: tell them honestly which are the points where you cannot attempt to go through the proof. These they must take for granted, just as all of us have constantly to take many things for granted, on the word of those who have studied them, when we ourselves have no time or no training to go into the proof. But I see no reason why an intelligent class—and no other is fit to take up this subject at all—should not carry away a clear notion of the way in which we find out the size of the earth. It may also interest them to see, once more, how curiously we go to the stars, millions of miles off, to tell us the length of the diameter of our own earth; that is, of a line passing through the earth from under our own feet to our friends or cousins in New Zealand.

96. **Its Movements.**—A larger subject comes next—the earth's motions, its *rotation* on its axis, and its *revolution* round the sun. You *described* them four years ago: you are now to try to *prove* them.

97. First, picture out to the class the position of the earth, as what you have shown it to be—a huge ball, hanging alone in space, with nothing to support it, and no other body within thousands of miles. They may naturally ask, *What keeps it up?* That is, more correctly, *What keeps it in its place?* You will answer this presently. But put it aside for the moment. You have first to answer the question, *Is*

[1] This is the *average* length; the actual length varies slightly, but you need not go into this with children.

it at rest or in motion? Of course the children will remember enough of former lessons to say at once, with one voice, that it is moving. It may be as well to check unreal or *sham* show of knowledge, by reminding them that, if they had been left to themselves, they would have been quite sure that it was at rest. We do not feel it move: the sun, moon, and stars appear to move round it, while it keeps still. Why are we sure that what seems so clear to our senses is really false—that what all men, old and young, wise and foolish, believed till these later days, was all the time a complete mistake?

98. There is a striking thought, on which you might dwell for a moment, as your first step before answering these questions. *It is in itself much more likely that such a body should be in motion than at rest; and it is most likely to move in two ways—to spin round on its axis, and also to move forward in space.* To make this clear to your own mind, you should read the pages of Professor Moseley's book, to which I refer you below.[1] Their substance is:—That such a body would *naturally* be put in motion, when first formed and set free in space; and that, unless the force that put it in motion acted in one particular way, which was very unlikely, it would have the two motions, one round its axis, and the other from place to place. In putting this thought before the class, you will of course be careful not to speak of it as a proof: it merely shows that what you are going to prove to be true in fact, is in itself what was likely to happen.

99. You can now take a step forward. Remind the class of your first picture of the heavens, with sun, moon, and stars steadily moving across the sky, day after day, and

[1] Moseley's *Lectures*, § viii. pp. 33-35. Professor Moseley assumes a creating 'Hand'; *i.e.* creation by a single act. If we suppose the body to be formed gradually, by the union of particles, the case is still stronger to show that motion, not rest, would be its natural state.

night after night. See if they remember what you taught them of the immense distances of the fixed stars. Make it clear to them, by diagrams and figures, what enormous circles they have to travel through in twenty-four hours, if they really revolve round the earth.[1] Then ask them, which is more likely—that all those bodies should travel daily through those enormous orbits, or that the earth—which was anyhow almost sure to be in motion—should turn round on its axis, while they remain at rest. These, as you can easily show them, are the only two ways of accounting for what you see; *either* (as people used to think) the earth stands still in the centre of a great sphere, and sun and stars move round it; *or* sun and stars are still, or nearly so, while the earth spins round on its axis. This is very plain, and soon put into words. But you must take pains to make sure that your children really follow you; it will not do to slur it over hastily. Do not be content till you are *certain* that they see that one or other of these notions *must* be true, and why it is far more likely that the earth turns on its axis.

100. **Principle of Attraction.** — Now for direct proofs. I will give you three—one of a general kind, and two from experiments. The two last may perhaps be new to you. For the general proof, you must bring in the principle of *Attraction.* You have had it already in one special form—*Gravitation.* You have now to explain the general law. Tell the children of Sir Isaac Newton, and the apple falling from the tree—how he began to think *why* it fell—and how his thinking led him on and on, till he made it quite certain that the same force which draws down the apple governs all bodies in nature,

[1] See Moseley, § viii. pp. 35-39. The distances of the fixed stars and their orbits (if they really revolved round us) are so enormous, that you could hardly give the children any clear idea of them. *Millions of millions of miles* would not be too strong a way to put it.

and keeps up nature's order all over the universe. We shall come back to this when we speak of the earth's *yearly* motion. For the present, all you want is a very general view of it; that, as bodies attract each other in proportion to their size, it is certain in every case that the larger of two bodies *cannot* revolve round the smaller; and, when one is very much greater than the other, the smaller *must* revolve round the larger. But the sun is more than a million times greater than the earth. It is therefore *impossible* that he should revolve round it. This argument is perfectly sound, and, like the others, could be put in strict scientific language. But, in this simple form, I think you may make it clear to children. And, if the sun does not revolve round the earth, it is clear that the *earth* must turn on its axis. For there is no other way of explaining all we see.

101. **Experiment of the Ball dropped from a Height.**—I take both the experiments I spoke of from a book of very high authority.[1] They will tax your powers of description, as you cannot actually try them, and I doubt if you could make them plainer by diagrams. But it is worth while to try; and they are sure, if nicely described, to interest your class. The first is this: suppose you are on the top of a high tower, or anywhere on a height where you can drop a heavy ball straight down. Let it drop on the *east* side. It is clear that, if the earth were still, the ball ought to fall close to the foot of the tower. But it does not fall quite close, but a little way to the eastward. Why is this? Only one reason can be given, and that is complete. If the earth is moving from west to east, the top of the tower is moving faster than the foot, because it is at a greater distance from the centre,[2] and has therefore gone farther than the foot in the time that the ball has taken

[1] Stubbs's edition of Brinkley's *Astronomy*, ch. vi. pp. 62, 63.
[2] See § 39.

to reach the ground. But the ball, at the moment it leaves your hand, is moving from west to east, at the same rate as the top, and it will go on moving at that rate all the time it is falling. It *must*, therefore, go farther in that direction than the foot of the tower, and strike the ground a little to the east of it. This is exactly what it does. This little space —less than half an inch in a fall of 250 feet—between the foot of the tower and the spot where the ball falls, tells us plainly that the earth is turning round. We can prove that it ought to fall in this way *if the earth moves, but not otherwise*; and then we go and try if it does so fall, and there it lies, exactly where our reckoning placed it! Just stop for a moment, and consider how careful and painstaking observers must be, to measure so small a line so exactly, that their measurement agrees as closely as possible with what has been separately worked out on mathematical principles. Learn two lessons: the value of little things, and the careful attention of great minds to little things, in working out large conclusions.

102. **Experiment of the Pendulum.**—The second experiment is even more interesting. A pendulum is set up on any spot on the Equator, and another on any spot between the Equator and the Pole. It is proved that, in the first case, the direction of the movement of the pendulum would not be affected by the earth's rotation: the pendulum would simply go round with the earth, and point always the same way. In the second case, the direction of its swinging must change every moment, and *appear* to move round from east to west. This really means that the earth is moving away from it eastward. The time that it will take to go completely round is exactly reckoned, differing for each place according to its latitude, and being shortest for those places which are farthest from the Equator. If you could set up a pendulum at the Pole, the time would be exactly one

day.[1] We cannot get a pendulum to swing long enough for this complete revolution. But it does quite as well to let it swing for a certain time, then measure how far it has swerved from its first position, and take the proportion between the distance it has moved in the time, and the whole revolution of 360 degrees. That is, if it had moved 9 degrees, we should say, as 9 to 360, so is the time we have watched it to the time for a whole revolution. The result once more agrees exactly with what it ought to be according to calculation. For example, at Cairo, whose latitude is 30′, calculation tells us that the time for moving 45 degrees ought to be exactly six hours. I do not know that the experiment has been tried at Cairo, but I am sure that the result would be the same. But you will observe that, in this experiment (as, indeed, also in the last), the fact of there being a movement at all is a strong argument, even if the calculation and the observation did not agree as to the extent of it. As it is, their agreement is perfect, and makes it absolutely certain that the theory is true. Do you think you can use this illustration? I may tell you honestly that I do not think it will be easy, and that you *may* have to teach children with whom it will be useless to try it. I leave it with you. Use it or not as you think best. But if you do use it, use it thoroughly. Don't make it a sham.

103. It may occur to you that there is no reason why you should *not* try this experiment for yourselves. By all means! I should be very glad to hear of any teacher having done so. Whether you will succeed is another matter. I must warn you that we are told on the highest authority that 'the difficulties of mechanical adjustment are very great.' The 'pendulum' must not be like that of a clock, connected with anything else,—it must be simply a heavy ball, hung by a string; you must get rid, as far as

[1] I add, not for teachers, but for possible critics, that of set purpose I do not trouble my practical readers with the distinction between a solar and a sidereal day.

possible, of *friction* in the string by which the ball is hung; the height must be considerable—not less, I imagine, than 20 feet, and perhaps even that may be too little; you must then have time and patience to watch it as long as it will swing; and, after all, the angle you will have to measure, to show the swerving, will be a very small one, difficult to measure with accuracy. Still, try by all means, if you are inclined to go thoroughly into the matter. Draw a line with chalk on the ground or floor, to show the direction when you begin, and, just before it stops, draw another line showing (as exactly as you can) the new direction. The angle made by these lines measures the amount of change. And, even if you cannot measure the angle, you may be able to show that there *has been* a change.

104. **Day and Night.**—*Day and night* will not now give you much trouble. The general reason is so plain, that you need no help from me in drawing it out. The only question worth dwelling upon is: Why are not the days of the same length all the year round? Why is it dark so long at Christmas, and light so long at midsummer? You know, of course, that the fact which explains this difference, and explains a good many other things also, is the position of the earth's axis. For the best way of putting this, and of drawing out at the same time whatever the children may know about it, see Huxley's illustration [1] and his remarks upon it.[2] You cannot do better than follow him exactly, only questioning on each of the three positions, rather than telling their effects: there is nothing here which intelligent boys should not easily think out for themselves. And by so thinking it out they will see and remember much better how much we gain by what seems so little a thing—the slant or inclination of the earth's axis.

105. **Yearly Motion.**—This brings you at once to the

[1] *Physiography*, fig. 111, p. 339. [2] Pp. 338-340.

yearly motion, the revolution round the sun. Huxley's figure, in the third position, shows you that this slant of the axis would of itself do no more than give one half of the world light and heat, leaving the other half in cold and darkness. This is not so. Why not? How comes it that every part of the world has, at different times of the year, its share of the rays of the sun? that is, what causes the succession of the seasons?

106. You might go on at once to answer this question—to show how the yearly journey of the earth round the sun accounts for these changes. If time presses, you may leave out this and the following paragraphs, and take up the seasons at once. But if you have time, it will make your teaching more complete to bring in first another fact, not so obvious, of which also the earth's revolution is the only explanation. That fact is the apparent movement of the sun among the stars.

107. '*Very strange!*' says the sharp boy. 'How can the sun have an apparent motion among the stars? *I* never saw the sun and the stars together!' No; but they are there, though the light of the sun is too strong to let the stars be seen till he ceases to shine upon us. We can observe and measure his journey through the stars, without seeing them together. We can note in the day time how long the sun takes to come back to the *meridian* of any place, and we can then in the same way note in the night time how long a star takes. This you should of course illustrate on the globe. It is found that the sun is always longer than the star, losing nearly four minutes every day. But we know that it is not really the sun which has gone round the earth, and come back to the meridian, but the earth has gone round on its axis, and brought back the meridian of the place both to the sun and the stars. Why then does it reach the stars first? They, you know, have not moved. It looks as if the sun had moved forward in the same direction as the earth, *going away from it* to the

eastward, so that the earth has to go on turning for four minutes more before it catches him. This is his 'apparent movement among the stars'; which, if you will reckon, will bring him completely round the circle in about a year.[1]

108. Your course is now clear. You remember, and you should see that the children remember, how you showed them that it was *impossible* for so large a body as the sun to revolve round this little earth. Therefore the 'apparent movement' cannot be a real movement. But if the sun does not revolve round the earth, there must be some other way of accounting for his apparent journey among the stars, and also for the changes of the seasons, for long days and short days, the heat of summer, and the cold of winter. Now it can be clearly shown that if the earth, slanted as we believe it to be, goes round the sun in a year, all these effects would follow: the daily movement of the earth would make the sun appear to have changed his place among the stars, and would also (as we shall see presently) cause all the changes of the seasons. On the first point, I refer you below to the simplest form of proof that I can find.[2] But I doubt if you can make it clear to fourth-standard children. The substance of it is, that when the earth has changed her place, you are looking at the sun from a different point, and therefore in a different direction. But the stars are so far off that the earth's movement makes no difference to your view of them. So the sun, which at first was directly between you and the star, appears at the end of a day to be a little to the side of it, and after a week to be a good deal to the side, and so goes on changing his place, till at the end of a year he comes back to where you

[1] The exact difference is $3' 56\frac{1}{3}''$ daily, which answers (at the rate of the earth's motion) to an arc of $59' 8''$. See Moseley, § xiii., and Huxley, ch. xx. pp. 340, 341. But for the class, the figures I have given are quite exact enough.

[2] Moseley, ch. xiv. pp. 64–67.

began. With the help of a simple diagram, I think you might bring upper boys to understand at least the outline of this proof.

109. **History of Discovery.**—At this point, when you have nearly done with the earth's motions, it would be well to tell them something of the history of men's thoughts and knowledge on this subject. The *notion* of the earth's rotation is a very old one;[1] but it remained a mere floating guess till Galileo and Copernicus took it up, and added to it the revolution round the sun. Others followed, especially Tycho Brahé, and by a large number of careful observations prepared the way for modern science. Two great men were still needed: those two were Kepler and Newton. Kepler's task was to reduce Tycho Brahé's results into order and system, and from them to discover the 'laws' of the heavenly bodies. Now, pause for a moment. You may perhaps have heard of Kepler's laws, and you may be able to write them out. What sense do you give to the word Laws? It is important to be clear about this, that you may not think or speak as if more had been done towards explaining the course of Nature than man has ever done or is likely to do. What Kepler did, was simply to take a vast number of facts already known, and to show that they all came under two or three general rules. He did not pretend to say *why* it was so. Take, for example, the first of his 'laws.' He found from the observations already made, how the distance of the earth from the sun

[1] As far back as the days of Cicero—*i.e.* before the birth of Christ—such guesses were afloat. '*Hicetas of Syracuse, as Theophrastus says, is of opinion that the sky, sun, moon, stars, in a word, all heavenly bodies, are at rest; that nothing in the universe moves, except the earth; and that all the same effects are produced by the earth's turning and twisting on its axis with the utmost speed, as if the heavens moved, while the earth was at rest.*'—Cicero, *Acad. Quest.* II., as quoted by Dr. Stubbs, ch. vi. p. 66. But these were mere vague guesses, leading to no practical result.

and the moon from the earth at different times varied; and putting these together, he showed that their paths were not exact circles but *ellipses*, with the sun in the *focus*. This was all; but it was a great deal. Any who doubted before must have been far more ready to believe, when they saw how every fact fitted into the new system, and how complete and simple that system was. I give you the three laws in a foot-note, trying my best to put them in simple language.[1] I will say a few words presently as to whether you should or should not try to teach them to the class. For the present, I will only say that the first is easy; the second is not hard, if you draw a good figure in illustration; the third *sounds* more difficult than it is: you *might* teach it by examples first, and so work up to the general rule. But it would take, probably, more time than you can afford.

110. **Law of Attraction.**—What, then, was left for Sir Isaac Newton? Again I say, stop and think; though I hardly expect you to think out the answer to this question. Yet try. Kepler has brought us so far as this: that we see that all the movements of the earth, moon, and planets, and all the apparent movements of the sun, can be summed up in three short rules or laws. What is the next step to be taken? Newton asked this question, and answered it. The next step

[1] These laws are:—

1. The earth and the other planets go round the sun in *ellipses* which are very nearly circles, and which have the sun in one focus.

2. If you suppose a line or rod stretching from the sun to the planet, then, as the planet revolves, that rod (called the *radius*) sweeps over *equal areas in equal times*; that is, in each day it will sweep over the same space, double that space in two days, and so on. Observe, the same *area*, not the same length of curve; and note that this *radius*, unlike the radius of a circle, is not of uniform length.

3. If we call the time each planet takes in going round the sun its year, the *squares of their years are in the same proportion as the cubes of their distances* from the sun.

was to prove that these bodies not only *do move* in this way, but that they *must* so move—to find out the force that compels their movements, to show how it acts, and to prove by rigid reasoning that, once we know of this force, all Kepler's laws and the facts which they explain *must* of necessity follow. A bold thought! so bold, that it had not fairly entered into the mind of any one of the able men who went before him. That force is the force of ATTRACTION. Here is Dr. Stubbs's account of it.[1] '*All the bodies of the solar system mutually attract each other; the force is in proportion to the mass of the attracting body*,' that is, the larger the body, so much stronger is the attraction, and if one body is very much larger than another (as the sun compared with any planet), the attraction of the smaller one is hardly felt; and further, '*this force is greater or less according as the distance is less or greater, and that in proportion*,' not simply to the distance, but '*to the square of the distance*.' So that, if the distance of one planet from the sun is thirty times that of another,[2] the sun will attract the second with a force, not 30 times, but 900 times, as great as that which acts on the first.

111. You cannot, of course, attempt to follow his reasoning. You must take for granted that it is very complete. He *proves* that any body moving in an ellipse according to Kepler's laws *must* be attracted by a force lodged in the focus, and acting in this particular way; and also that a body so attracted, if subject to another force, which we shall come to immediately, *must* move in an ellipse. And so, as we said at first, all these mighty worlds are kept in their courses by the same force which makes an apple fall from the tree.

112. But does it not occur to you that there is still something wanting? Why does not this force draw all the planets straight into the sun? It would draw them, or rather it

[1] Brinkley's *Astronomy*, ch. xxi. pp. 293, 294.

[2] This is nearly the proportion of the distances of the earth and Neptune.

would have drawn them long ago, as the earth draws the apple, had they not been at first launched into space with a forward motion, which but for the sun's attraction would have carried them on and on for ever in a straight line. These two forces, acting together, keep them—and, as Newton proved, *must* keep them—for ever in the ellipse. The forward impulse keeps them from falling into the sun; the sun's attraction keeps them from running off into space. Of all effects of thought by one man's mind this of Newton's is perhaps the most wonderful.

113. Since his day much has been done—many new stars and planets have been discovered—many questions which he left unsettled have been set at rest. If he were to come alive again, and look into the books of the present day, he would find page after page filled with matters quite strange to him; questions which gave him trouble spoken of as clear and simple. But one thing he would *not* find: he would not find a single fact brought to light since his death which even seems to contradict his great theory. Every new world has, as it were, fallen into its proper place in the system, and each advance in knowledge has only made clearer and clearer the truth and wisdom of his teaching.[1]

114. **Can all this be taught?**—I now come back to the question, which I do not doubt is in your minds, Can

[1] One of the most remarkable examples of this is the discovery of the planet Neptune. For many long years, down to our own time, the planet Uranus—then thought to be the most distant then known—seemed as if he *would not* move in his proper path, the path in which he ought to go, allowing for the attraction of all known bodies. Either Newton's theory failed, or something drew him out of the path. Two astronomers—one French, one English—set themselves to settle this question. Working separately, they came to the same conclusion, and pointed out the place where a new planet would be found, and the size of that planet. Neptune was found exactly where they expected to find him; and what had so long looked like an exception, gave fresh witness to the truth of Newton's principle.

I hope to carry children with me through this long chain of close reasoning? My first reply must be, Do you understand it yourself? If not, it is very clear that you had better let it alone. If you do, you must consider what the children can really do. A fourth standard, as I have already said, cannot be expected to take this in : it needs closer attention than they are likely to give. But then very few fourth standards are fit for this section at all. It may be, however, that you have to teach a well-advanced class of older boys. In that case, I should certainly try. You have to aim at a higher mark than to 'pass' them for the grant. It will be a great point gained, if you only give them so much insight into this great field of thought as to make them wish to know more about it. For boys whose school-days are nearly ended, mere cram-knowledge is as nothing compared with habits of active inquiry; and few things would do more good to their intelligence than to get a peep, as it were, into these great works of master-minds. Therefore try! Put all thoughts of grants out of view; think your hardest, and teach your best. In any case, I could not refrain from setting down for you, even if it be for yourselves only, these rough outlines of a great subject.

115. **Seasons.**—We come down again from sun and stars to our own earth. But the seasons need not now give you much trouble. You have already shown the children that the earth's axis is *inclined*, or slants, towards the sun.[1] As it revolves round the sun, keeping the axis (as it must do[2]) always in the same position, it is easy to show how the seasons change, that is, how we receive more light and heat at one part of the year than another. Any common text-book will give you this. You will find it nicely put in Huxley.[3] The only point that needs special care is to guard the children from supposing

[1] See Huxley, p. 339. [2] See Moseley, ch. xvii.
[3] Ch. xx. pp. 350–354.

that we get most heat when the earth is nearest to the sun. Show them that, in the nothern hemisphere, this is not so. And bring out clearly the two real reasons for the greater heat of summer, the longer light, and the more perpendicular rays of the sun.

116. **Planetary System.**—Of the remaining subjects in the schedule, I prefer taking next 'the general arrangement of the planetary system,' because it follows so easily from what we have been saying about the revolution of the earth. There is not, indeed, much more to say about it. Each planet obeys the same great law of attraction, and describes an ellipse round the sun, exactly like the orbit of the earth.[1] In some respects it is easier to observe their movements than our own, because we see them as they really are—there is no apparent motion of the sun to disturb our ideas.[2] Their names, sizes, distances from the sun, and times of revolution, you can find in any text-book. They should be got up carefully, but need not take much of school time. It might interest your more advanced scholars, when they have learnt these figures, to try for themselves how closely Kepler's third law holds. You will of course warn them that the result will not come out quite exact, because (among other

[1] A very beautiful illustration, and indeed one more proof of the way in which the force of attraction works *everywhere*, is the little system of Jupiter and his four moons or 'satellites.' It is a little solar system in miniature, except that the light is all borrowed from our sun; and all the movements of these satellites, as well as those of Jupiter himself, as seen by observers, are exactly what can be shown to be the result of the same great force of attraction or gravitation. See Moseley, § lxviii. pp. 198–201.

[2] If I were teaching an advanced class, I should be disposed at this point to spend a little time in describing the manner in which observations are made, the instruments employed, &c. But this, though interesting, is not necessary; and there is at least as much set down as the teacher can accomplish in the time allowed.

reasons) the longest of these decimals is only what we call an approximation—nearly right, but not perfect.[1]

117. **The Moon.**—The moon's 'dimensions and distance' are easily disposed of in the same way. Her *phases* need rather more attention, but they are easily explained on the principles already laid down. The earth being so much nearer to it than the sun, and much larger than the moon, attracts it more strongly; and so the moon not only *appears* to go round the earth, but really goes round it, the time of its revolution being nearly 28 days, or what we call a lunar month.[2] All this is only another case of the law of attraction on bodies which have at first received a forward motion. You should now be able, with the help of a diagram,[3] to draw from the class the reason for those changes in the appearances of the moon which we call her *phases*—new moon, full moon, and the quarters. This should be carefully done, but presents no difficulty. It all depends on what is perfectly clear—that it is only half of the moon's surface which receives the light of the sun; and of the face turned towards us at any time (except at full moon), part or the whole belongs to the darkened half.

[1] A convenient device, to escape these long rows of figures, is to take the earth's radius as a unit: call it 1, and express all the other measurements as so many radii. This does quite well, so long as you want *proportions* only: if you want actual sizes, times, or distances, you must multiply at last by the length of the radius.

[2] This, of course, is the true 'month,' according to the derivation of the word. Our months of 30 and 31 days are artificial divisions of time; that is, they do not answer to anything in nature, but are merely adopted for the convenience of cutting the year into twelve parts. I should take this opportunity of impressing on the fourth standard, that in working sums where 'months' occur, if they take them as lunar months of four weeks each, they must reckon thirteen to the year.

[3] See a simple one in Moseley, § xxxviii. p. 129. You need not trouble yourself with his minute explanation.

118. It may help to make this plain, though it does not really affect it, to call their attention to another fact. We said, in speaking of the earth, that it was almost certain to have received at first, not only a forward motion, but also one of rotation. Has the moon such a motion? Does she turn on her axis? Yes, but so slowly that she always presents the same face to the earth. This we know by observation. I leave it for you and your scholars to find out how long she takes to turn, and what is the length of a day to the inhabitants of the moon, if there are any.

119. **Conclusion.**—My lessons and hints are ended at last. In looking over them, I cannot but feel that some among you will be tempted to say: 'This is too hard—there is too much of it—it is not worth my while to take so much pains and thought over a single subject, and that not one of the most essential.' To that I have two answers to make. *First* as to the quantity. I agree that there is more than can well be mastered in the time you are likely to have for it;[1] but something might be done to gain time by preparing children before they come regularly to it, by teaching them some of the simpler parts as extra lessons in the third standard. A more important gain—and I believe the only way of doing sound work—would be to make up your mind from the first *not* to present the fourth standard in this subject at all. Let them, year by year, take the lessons, or some of them, alone or with the older ones, as the case may be, *as if* they were to be presented. But do not present them. Look on the first year's teaching as a rehearsal, and then, the year after, you might fairly hope to make their knowledge sound and thorough. *But this will not pay!*

[1] Yet I have left out many very interesting points; for example, the argument from the 'Aberration of the Fixed Stars'; not that I think it harder than some I have touched upon, but because I was afraid of giving you too much.

No, not in grants. If you are working for nothing but grants, this little book is not written for you.

120. Lastly, my second reply. If you think my way of looking at things too hard, I quite admit that it is too hard for many scholars, and for many teachers too. But if it cannot be done in some such way as this, it is not worth doing at all. To teach it by dry definition and 'cram-work'—to skim the surface of the subject, without getting fairly into it—to give children so many hard words and phrases without really leading them to look for themselves into the great book of nature—is to degrade a noble study into something worse than a waste of time.

PHYSICAL GEOGRAPHY—the full picture of the earth and her place in the universe — the laws which govern her movements, and the wonderful completeness and harmony of those laws—*this* is indeed a science well worth much study and patient thought. Do not degrade it. If you cannot or will not throw your mind and heart into the work, do not teach it at all. It will be every way better for the children to know nothing about it than to go away with a smattering of empty words, and fancy they have learnt physical geography.

121. But if you have honestly tried, and in fair measure succeeded, let me give you in parting a theme for your closing lesson. I do not think it well to be too free in mixing up religious thoughts with ordinary teaching. They are apt to grow commonplace and threadbare. But when you have gone over, and brought into one view, in your final revisal, the various proofs of one exact system of law working through the universe, it will not be out of place to point the lesson which they teach. These different impulses, so exactly balanced, and all combined to sustain this perfect order, point to no blind chance, but required, in the words of Newton,[1] 'the Divine arm to impress them.' As cloud

[1] Third letter to Dr. Bentley, as quoted by Stubbs, p. 295.

and mist, rain and snow, river and ocean, so sun, moon, and planets bear the same witness—do not be ashamed of the old-fashioned couplet—

> 'For ever singing, as they shine,
> 'The Hand that made us is Divine!"'

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HOW TO TEACH 'MECHANICS.'

CHAPTER I.

MATTER, ITS PHYSICAL STATES AND PROPERTIES. MEASURES OF EXTENT, TIME, AND VELOCITY.

1. **What we understand by matter.**—This term includes everything that comes within the reach of our senses, but especially of our sight or touch, acting either separately or together. Children should be early trained to classify objects that are brought within their experience by sight or by touch or by hearing, and to recognise those objects especially that are brought to their knowledge by a combination of more than one sense. The senses should be properly trained to assist each other. The eye deceives us in pictures, and is corrected by the touch. The touch, again, is liable to be deceived in the dark; even in the light, if the second and third fingers be crossed and the ends rest on a marble, two marbles may be felt instead of one. Our hearing also can with difficulty determine the direction from which a sound proceeds. You, probably, are not likely to trouble your own head or the heads of your scholars with questions as to what matter *is* in itself. If you are asked, 'What is matter?' say, 'Never mind;' or, 'What is mind?' say, 'It does not matter.'

All that the children need know about matter is the fact

that the things we see about us have the power of affecting our senses and causing sensations, and that these sensible qualities and our sensations are the only objects of the student of nature. *It should be borne in mind that there is no similarity between the sensation and the power that gives rise to the sensation.*

2. **Impenetrability of matter.**—This is the chief groundwork of our knowledge of matter; and perhaps the resistance of matter is so inseparably connected in the minds of children with the greater resistance of solid bodies that our first effort should be directed to teaching children the *impenetrability* of all matter, whether solid as stones, or liquid as water, or of the nature of a gas, as the common air we breathe. By impenetrability we understand the lesson gathered from experience, that different bodies must lie *outside* each other, that *no two bodies can be at the same moment in the same space.*

They will readily understand this truth as applied to solids, such as stones or apples. But they might be disposed to dispute the truth of the impenetrability of all matter, unless we gave them a proper explanation of the absorption of liquids into porous solids, as tea is absorbed into sugar, or of the diffusion of gases, of which they have a common instance in any ordinary escape of gas. Reserving such cases for further explanation, let the class witness the experiment of trying to force a large cork into a jar whose mouth exactly fits the cork, without allowing any of the water to escape or bursting the jar. Place an inverted tumbler within a larger tumbler nearly filled with water, so that some of the air in the smaller tumbler may escape, and let the children observe the air displacing the water. They will also notice the different levels of the water in the two tumblers, and will understand that the air which remains in the smaller tumbler is impenetrable to the water. Supply salt to a tumbler of water till the water is fully saturated; and they

will see that this mixture is impenetrable to any addition of salt, and resists its intrusion.

3. **How far matter is divisible.**—It can easily be shown that matter is divisible to a certain point; but a more minute division, visible by microscopic aid, as in the case of lines $\frac{1}{1000}$th of an inch apart, cannot so readily be explained.

Some idea of its divisibility, beyond the power of the senses to estimate, may be inferred from the fact, that a grain of musk may throw off, year after year, small particles of its substance, so as to scent a whole room, and yet, if it be weighed at the end of years, it will be found to have suffered no sensible diminution of its weight. Whatever it has thrown off in the course of that time must be so small as to be below our power of estimation. We could wish that every school possessed a good microscope for the mere purpose of proving the existence of another world indistinguishable by our common eyesight; e.g. in the structure of plants, parts of a common forget-me-not, in the sting of a wasp, or the eyes of a fly. The existence of this distribution of parts below that ordinarily seen would be a great step towards the recognition of a still lower division, and the knowledge of each subdivision would lead the class to acknowledge the possibility of one still lower. A grain of sand, supposed to be the lowest, would prove under the microscope to be still divisible. A piece of chalk might be shown to be composed of an immense number of small shells, and from the nature of their composition each of these shells must be composed of particles immeasurably smaller in size.

4. **Matter not infinitely divisible.**—So far as the mechanical subdivision of parts by the help of powerful microscopes has been carried, it would appear that there is no limit to the divisibility of matter. But from the results of experiments it is known that if chemical mixtures be

formed of different substances, whether we take a large or a small quantity of the mixture, the different substances will always exist in the same proportions; e.g. in laughing-gas there will always be found the same proportions of oxygen and nitrogen, whatever quantities of the gas be taken. We assume from this, that if we could divide substances sufficiently, we should arrive at some ultimate atoms still possessing sensible qualities; e.g. of weight.

5. **Linear extension.**—So far we have dealt only with the first pleasurable impression of a child—that resistance to the touch which gives delight to the first handling of toys. In connection with this feeling of resistance a blind child would, by the sense of touch only—that is, by passing its hand along the edge of a body—gain its first impression of linear extension. But all sighted children combine the senses of touch and sight, and probably, after the first experience, rely upon the latter, even at the risk of being deceived. From straight edges we pass to curved edges of various kinds, circular, oval, &c.

6. **Superficial extension.**—The idea of surface is gained by passing from the line or series of points we have been following to other series of points diverging from the same point in all directions. Only one more condition is required to determine fully the form and magnitude of a body, viz. its depth, or the distance of any point in one of the surfaces from the point nearest it in another. We have then arrived at the idea of a body occupying a certain space, as defined by these three dimensions, occupying the space at a certain time to the exclusion of all other bodies, and presenting a certain resistance to the efforts we make for the separation of its component parts. In other words, *matter possesses form, is impenetrable, and presents resistance.*

7. **The solid state of matter.**—Some bodies present sensible resistance to the separation of their parts; e.g. in

the case of large pieces, as in sawing or chopping; or of the smallest particles, as in grinding powder, or in the action of the sea forming the sands of its shores. Some force must be exerted in the division or forcing apart of any particle into still smaller particles. These bodies are said to be *Solid.*

8. **The liquid form of matter.**—Other bodies, as water, or oil, present scarcely any resistance to the separation of their parts. It is generally said that they yield no resistance, but this is not exactly true. Allow a piece of wood to float in a basin of water, and you will require some slight degree of force to separate the wood from the water. Let children notice the difference between picking up the same object from a perfectly dry and from a wet surface. It is not easy to detach small drops of water from the window pane; large drops flow readily down it. Heap a tumbler full of water, and the water rises above the edges of the tumbler. The resistance to separation of parts is so very slight that it is quite sufficient to say that the parts of liquids require only a very small force to separate them, and that for all appreciable purposes this resistance may be disregarded. Bodies, whose parts may be separated with scarcely any appreciable effort, are said to be *Liquid.*

9. **Attraction of matter.**—We notice one distinction between solids and fluids which children will readily understand, viz. that if we grind stone to powder, or file wood to dust, the powder or dust will never *form drops.* You can moisten them and form another solid of more or less cohesion, but you cannot form anything of the nature of a drop of water. We should state first the general law that *all particles of matter, when placed very near together, attract each other, whether in the solid or the fluid state.* For example, if two small pieces of cork or other light substance be placed on a basin of water, they will be found to attract each other,

and two small drops of rain on the window-pane will often flow together.

In solid bodies the particles attract each other with such force as to require considerable effort to separate them, but the small particles once separated cannot come together again with ease. In fluid bodies, though the attraction is less, the small particles can roll, or slip, or glide over each other more readily than one ball can roll over another, and can easily come together if placed sufficiently near.

10. **The particles of bodies are not in actual contact.**—In the ordinary states of bodies, when one rests on another, or when we press two bodies together, we fancy that these are actually touching; but they are not really in contact, and can be easily separated, showing that air presses equally on all sides of the bodies, and therefore separates the surfaces apparently in contact. If the air is removed from between the two surfaces in contact, the pressure of the air on the other parts of the bodies will tend to prevent their separation. It might be thought that now, at all events, the bodies were actually touching, but there is still some space probably between the two surfaces. We may advance a step further, and say that not only can two bodies not be made to touch each other, but that in the same body, even in the case of the densest substances, the particles of the body are not in contact, but are only held together by a very strong attraction, the force of the attraction varying in different bodies.

11. **The gaseous form of matter.**—We have seen that in solid bodies the particles are held together by an attractive force; that this force prevents the separation of the particles, and cannot be overcome without appreciable effort. In liquids they are held together very slightly, so that no appreciable force is required to separate them. Another state of matter is *the gaseous state, in which the particles no*

longer attract each other, but exercise a repulsive force, and would force each other to a constantly increasing distance unless kept together by external pressure.

12. **Capillary attraction.**—We recommend the teacher to employ some simple illustrations of this property of certain bodies before considering the general porosity of all matter. It is found that if we plunge narrow tubes of different diame-

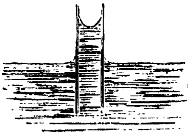

Fig. 1.

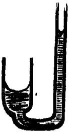

Fig. 2.

ters into water, the water will stand at different heights in the tubes, and at a greater height in the narrower tubes. Some kinds of liquids will stand higher in the same tube than others, and some will present a convex appearance on the surface, others a concave, according to the nature of the liquid and of the tube. It does not follow that the same liquid will be elevated in tubes of different materials, or even be elevated at all: indeed, if we were to plunge the same tube into a trough of mercury, the mercury would stand at a lower level in the tube than in the trough. It is found that the *narrower the tube the more marked are the effects noticed above* (see fig. 2), *especially if the tube be so narrow as to resemble a hair*, hence the name *capillary* attraction (*capillus*, Lat.=a hair) has been given to it to distinguish it from the ordinary attraction of gravity.

We see, therefore, that liquids are not affected as solids are, merely by their weight and the pressure of the atmosphere, but that at very small distances capillary attraction counterbalances all other forces. You may illustrate this easily to children by plunging a smooth stick (a rod of glass

shows this most readily) into a basin of water; when you withdraw the stick a round drop forms at the extremity, and this drop gradually elongates and remains suspended, the attraction of the glass rod counterbalancing the weight of the drop.

Referring to the constitution of liquids given before—viz. that they are composed of atoms which separate readily, and roll or slide easily over each other—we see that unless some force, such as the attraction of the particles of glass and water on each other, kept them together, the lower parts of the drop would separate themselves and fall first, followed by the others. If this result is produced in the open air, it is evident that the similar results in the tube have no connection with pressure of air, and that there is an attraction of the nature described above, both in the air and in narrow tubes, only with effects more marked in this latter case.

13. **Porosity of matter.**—All children will be familiar with the common instances of porosity to be seen in sugar, sponge, blotting-paper, &c. They will probably be able to understand an intelligent lecture on the porosity exhibited by the human skin after a hard game of cricket. They can be brought to understand also the rising of the sap in the trunk, branches, and leaves of a tree, when it is evident that there is no force except capillary attraction which can raise the water from the soil; the sections of juicy plants will be sufficient to prove to them the existence of such narrow, hair-like passages in the leaves. The pores of which we have already spoken can be made visible by the microscope, and from these the children may be brought to infer a porosity beyond the power of the microscope, viz. of substances which dilate and contract according to temperature, and they will understand that if the ultimate atoms remain the same the dilatation and contraction can only take place in the narrow passages between the atoms. This consideration will prepare them

for the statement of the general law of porosity of all matter —a law which is beyond the power of the human eye to discern, and even *beyond the power of the microscope*, and can only be assumed, though with great probability, as applicable to the densest substances. The general law briefly alluded to is this : *in all bodies* (*even the densest*, i.e. *in which the particles seem to be packed most closely*) *there are* probably *vacant spaces surrounding each of the atoms composing the substance.* Under the ordinary pressure of the air, water will rise by attraction in the pores of sugar or of a close sponge; ink will fill the pores of blotting-paper. Under a greater pressure aiding the effect of capillary attraction, liquids may be made to penetrate much denser substances. Hence we infer that all matter could be made to exhibit porosity if pressure sufficiently great were applied.

14. **Matter is compressible.**—All matter is compressible, whether in the solid, the liquid, or the gaseous state, gases generally being more compressible than solids, and solids than liquids. This compressibility is a natural consequence of the porosity. If we take a rod of iron, we find that we can bend it into a hoop, in which case of course the particles of iron on the inner side of the hoop have been brought more closely together, or compressed in the direction of its length, while the particles on the other side have been pulled farther apart. Again, the whole mass of a solid may be compressed into a mould by pressure, as in brickmaking, or in compressing hay or cotton for shipment. This capacity of alteration of form gives a peculiar value to some solids. For example, steel is ductile, i.e. may be drawn out to a very great length in thin wire, as sealing-wax when melted may be drawn out into long thin threads. Again, tin and gold are malleable : that is, they may be beaten out by hammering into very thin plates—so thin, in fact, that the thickness of gold leaf may be less than $\frac{1}{100000}$th of an inch. Some bodies will resist pressure, but will not resist a blow;

some are malleable, but not ductile, and *vice versa.* Beams of wood, again, may be broken by heavy weights, the fibres on one side being pulled asunder, while those on the other are compressed. It is found that if a force be slowly applied for a considerable time, it produces a greater effect in the long run than the same force suddenly applied, showing that the constitution of the particles of stone and wood has been slowly changing under pressure. Again, metal may be twisted, as well as compressed or beaten; in this case any two contiguous particles are drawn farther apart, except in the centre of the twisted mass.

Only one of these forms of pressure of the different particles upon each other is shown by liquids and gases, viz. that of compressing the whole mass enclosed in a vessel, so that none can escape in any direction. We cannot push water or gas in a straight line without developing in it a tendency to escape laterally; liquids and gases will either flow out or rise upwards under pressure, unless actually enclosed.

15. **Elasticity.**—We cannot, it is true, demonstrate to children that constitution of bodies according to which we suppose them to consist of collections of separate particles of matter, very closely put together; but we draw the inference that they are not in any way hooked or fastened together from the fact that if we heat a body it swells, if we cool it it contracts; our explanation being that the spaces between these very small particles, which are beyond our power to measure in any way, by sight, or by touch, or by weight, grow larger in the former case and smaller in the latter. We suppose, therefore, that in the state of a body not affected by any forces from the exterior, there are internal forces exerted by the particles of matter upon each other, which keep them in their (as we call it) natural state. If we then, by applying a force from without, either compress or pull out the body—i.e. if we alter the natural state—what should we expect to follow when this ex-

ternal force is withdrawn? That the internal forces only being left will be able to exercise their power without interference, and will re-arrange the particles in the former or natural state. It is this property of recovering the natural state, after the withdrawal of the external force, which we call *Elasticity*. Elasticity is said to be perfect when the body recovers exactly its former state in the same time that was required to alter it. No body in nature possesses this perfect elasticity, though gases, when compressed, possess a very high degree of elasticity.

16. **Degrees and limits of elasticity of solids.**—If solids were perfectly elastic, they would suffer no change of form after being drawn out, or compressed, or twisted. Indiarubber will undergo enormous pressure and yet be scarcely (if at all) altered in shape when the pressure is withdrawn. But nearly all other substances, under great pressure, undergo considerable change of form. A thin wire or thread, pulled out by a small weight, may recover its original length; but if pulled out by a heavy weight it will be permanently lengthened, and the particles will have undergone some permanent re-arrangement. Steel springs in railway carriages must be constantly tested by tapping with a hammer; an experienced ear can detect by the ring whether the particles have undergone any relative change of position, and, if so, the elasticity of the steel will have been affected. Again, a force acting continuously for a considerable time destroys elasticity by altering the condition of the particles, and we call this *wearing out*; the walls of a house will bulge out after a time, and the beams will begin to give way. This happens when the limit of a body's elasticity has been reached. A wire may be stretched to a considerable length, and so long as it bears stretching it will return in some degree to its original shape; but there comes a time when the limit of its power of elasticity is reached, and the wire will not stretch any more, but will break. We see

this in the various degrees of tenacity of metals. Lead is one of the least elastic of metals, and is one of the least tenacious (i.e. able to resist a weight without breaking), whereas tempered iron is one of the most tenacious and elastic. Without accurate knowledge of the strength of materials, none of our public buildings could be safely erected.

17. **Power of bodies to resist compression and extension.**—These are the two chief considerations in the construction of buildings. We have seen that almost all materials may be broken after a time by a pressure that they can defy at first. Builders, if they are honest men, will put into a house beams and other materials that will stand the work they have to do for years to come, i.e. they will consider the proper working strength of their materials. A dishonest builder is satisfied if he puts in materials that will not break at once. Telegraph wires must not be so long as to exceed the elastic strength of their materials. A careful builder will increase the depth of his joists rather than the breadth. A certain proportion between the length and thickness of the hollow pillars that support the roofs of warehouses must be preserved, otherwise they will be liable at any moment to be crushed. All these proportions must be determined by experiment, because we cannot see the arrangement of the particles of the mass.

18. **Structure of solids.**—Though we cannot see the ultimate arrangement of the particles of a body, we can see that different bodies are arranged in layers, or crystals, or fibres, and that they resist pressure with very different powers, according to the way in which it is applied. It is easy for a carpenter to plane a piece of fibrous wood by following the grain of the wood, but much more difficult to plane a knot in the same wood, where the grain ceases. It is very easy for an experienced quarryman to split the layers of slate, when an unpractised eye can see no cleavage.

Flints or glass present no apparent arrangement of any kind. Many minerals, again, form beautiful crystals of regular shape. This crystallised appearance is presented after long-continued pressure, but especially after sudden shocks, showing that the natural tendency of many bodies is to arrange their particles in the form of crystals.

19. **Liquids almost incompressible.**—Liquids are elastic in the same way as solids—i.e. they are compressible, and tend to resume their former positions when the pressure is removed—but only to a very small extent. No ordinary experiment will demonstrate the very slight degree in which they are compressible. Happily, for such work as pumping water, when we drive the piston downwards no appreciable work is lost by the water being compressed. Indeed, it was thought for a long time that liquids were not compressible, but this idea arose from false conditions of experiments. We see, therefore, that though the particles of water can roll or glide over each other under the smallest pressure, so long as they have space to move they resist with enormous power any attempt to compel them into closer proximity.

20. **Comparison of liquids and gases.**—A liquid possesses two fundamental properties—

(1) Ease with which its particles roll or glide over each other.

(2) Elasticity, or the power of returning to its shape after compression.

In the same way—

(1) The particles of gases slide over each other with greater ease, probably, than those of liquids; from this we infer that pressure is easily distributed throughout a body of gas, and that the particles of a gas are, like those of a liquid, separable by the smallest force.

(2) They are elastic and compressible, but in very different degrees. While liquids possess elasticity in a scarcely appreciable degree, gases are very elastic. If we invert a tumbler in a basin of water, the air in the tumbler is compressed or resumes its volume, according as the tumbler is depressed or raised. We may here notice Boyle's law of pressure, viz. that if gas is submitted to different pressures, it occupies spaces in the inverse ratio of the pressures; e.g. a weight of 45 lbs. would compress a gas into a space one-third of that which it would occupy under a pressure of 15 lbs. Vapours, again (by which term we understand substances which, under ordinary conditions, would be solid or liquid), are all elastic in the same way as air.

21. **Interchange of the three states of matter.**—We see, for example, that at the ordinary temperature of the atmosphere water remains liquid. But this is not so under other conditions of temperature and pressure; and we may state generally that these three conditions of substances, the solid, the liquid, and the gaseous, depend upon varying circumstances.

If we take a piece of iron, we find that it is hard, like ice, and that its particles, as far as we can see, do not alter their positions. But if we apply heat we can melt the iron and reduce it to a state like that of water. If we apply more heat we can reduce it to the vapour state.

Again, ordinary gases require great cold and pressure to bring them to the liquid state, and still greater to make them solid; indeed, some few of them have resisted the greatest degrees of pressure and cold to which we have yet been able to subject them, and have remained in the gaseous state, though there is the highest degree of probability that by still greater pressure or still more intense cold they would be reduced to the liquid state.

If it is winter, let us examine a lump of ice. We see that it is hard, and that its particles adhere firmly to each other. Now let us warm the ice gradually; at a certain temperature we shall find that it suddenly turns into water. After observing that the particles of water cling to each other, but not so much as in the ice, and are separable by a very small force, we proceed to raise the temperature still further. Suddenly again the water becomes converted into steam, whose particles, unlike those of the water, and still more unlike those of the ice, not only do not attract, but even repel one another, so that the steam occupies a much greater space than the water occupied.

It is this sudden increase of volume, in the change from water into steam, that causes explosions in kitchen boilers when water is poured into them while they are at a very great heat.

22. **Measurement of lines.**—All lines, whether straight or curved, according to Euclid's definition, possess only length, i.e. if we pass from one point in a line to another, we pass in two directions only, and no more, along a series of points. We cannot easily understand such a thing as 'length without breadth,' but we may consider a body as being practically no wider than just enough to satisfy our sight and touch. In order to compare one line with another, or to give an accurate idea to others of the length of a line which we have seen, some standard unit of length must be adopted. If we say a line is equal to 3, it means nothing without the addition of the unit of length: the expression may mean feet, or inches, or miles. The importance of this is seen in maps, where the scale of miles to an inch is given. A foot is the general standard of length agreed upon in England for ordinary distances measured by mechanics; for longer distances the chain is used. The standard foot is a certain distance measured along a bar, carefully preserved in London, when the bar has been

brought to a certain temperature. It will be noticed that if we employ a greater unit of length, any given line will be expressed in fewer units, i.e. *the measure of a line varies inversely as the unit of measure employed.*

23. **Measurement of surfaces.**—Again, a surface is considered to be possessed of length and breadth only, without depth. Practically, we mean that it contains no greater depth than may be sufficient to satisfy our sight and touch. It would be absurd to measure the size of an area according to a standard different from that by which we measure its sides. It is usual, therefore, in England, to measure areas in square feet, i.e. in units of area, each of whose sides is a foot and equal in length to the unit of length. Thus a surface might be expressed as containing 8 or 72 units of area; no confusion would arise so long as it was understood that the first implied a square yard, the second a square foot, as the unit of area. In this case, as in measurement of lines, it is seen that *the measure of an area, expressed in numbers, varies inversely as the square of the number expressing the unit of length.*

The same consideration might be extended to solids, which possess length, breadth, and depth, and we should find that *the measure of a solid, expressed in numbers, varies inversely as the cube of the number expressing the unit of length*, e.g. a solid might be said to possess 8 or 216 units of volume, according as we take a yard or a foot as our unit of length.

24. **Measurement of time.**—As we express the magnitude of a line in terms of the unit of length, so we express the magnitude of a certain time in terms of the unit of time. Thus we might express an interval of time by 5 or 300, so long as it was understood that the unit of time was in the first case a minute, in the second case a second of time. We see that *the numerical measure of a time varies*

inversely as the length of the unit of time in which it is expressed. The second of time employed is the second of mean solar time, and is taken from the oscillation of a pendulum of a certain length at a certain placé. A second is generally taken as the unit of time because in varying forces a longer unit would be too great for the expression of all the variations which might have taken place in the longer time.

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Erratum

On page 19, § 25, lines 15 and 17, *transpose* the words 'a second' and 'a minute'

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25. **Measurement of velocity.**—The rate at which a body is moving means the space it passes over in a certain time. In the consideration of velocity two units are involved, the unit of space and the unit of time. If I say that a body has a velocity of 3, I might be asked what unit of time I had taken and what unit of space. If I had taken *a foot* as the unit of space and *a second* as the unit of time, and another person had taken *a yard* and *a minute*, the measurement of the velocity of a body expressed in my system of units would be 180 times as great as if expressed in the other system of units.

CHAPTER II.

ENERGY AS EXHIBITED BY MATTER IN MOTION AND BY HEAT. THE CONSERVATION OF ENERGY.

1. **Matter at rest on the earth.**—We see that all things about us occupy the same or different spaces in consecutive intervals of time. If a body continues to occupy the same space, we say it is at rest; if it occupies a different space, we say it has moved. But it should be remembered that, in saying that a body is at rest, we mean at rest *relatively to ourselves.* As a matter of fact, both we and the body are being carried along with the earth in its motion, and never do actually occupy the same space in two consecutive moments. We form, in fact, part of the moving earth, which we are too apt to consider as a body disconnected from ourselves.

2. **Matter at rest within a body in motion.**—This relativity of rest upon the earth will be found very useful in enforcing the relativity of rest in a body which, unlike the earth, is sensibly felt to be in motion. A ball lying on the floor of a railway carriage, travelling sixty miles an hour, is at rest *relatively to the railway carriage*, though in rapid motion relatively to the ground beneath the carriage. This appearance of rest of heavy objects in a railway carriage has often led thoughtless travellers into such dangerous practices as throwing empty bottles out of the windows of a train in motion. We see, therefore, that relative rest with

regard to one set of objects may mean very dangerous motion relatively to another set; and that if two bodies move at the same rate, and in the same direction, they may be considered at rest relatively to each other.

3. **Inertia of matter.**—This term merely implies the inability of matter to alter *its own state* of rest or motion. It will be seen hereafter that all bodies in the universe exercise a power of attraction *upon each other*, and would produce motion in each other, if no stronger force, such as friction, intervened. This principle of the inertia of matter may be more fully stated thus: *if a body is at rest, it will continue at rest, or if in motion in a particular direction, it will continue to move in the same straight line, at a uniform rate, unless some force intervene to alter its state.*

4. **An absolute state of rest is practically unknown.** The first part of the principle of inertia states that if a body is at rest, it will continue at rest, unless some force occur to alter its state; and it would probably be inferred by children that all bodies that appeared to them to be at rest were not influenced by any external force. The fact is that there is no such case in nature, for all the bodies that we see about us are retained in their places by an equilibrium of forces. On an inclined plane smooth bodies, as marbles, or globules of quicksilver, will roll at a very slight inclination; rougher substances require a greater inclination before their state of rest is destroyed. On a perfectly level table a body would remain at rest, unless some external force intervened; but these conditions cannot be realised. We can, however, from the fact that some bodies depart from their state of rest more easily than others, infer that *in all cases* a greater or smaller amount of force is required to keep bodies practically at rest. The inertia of matter should not be supposed to be *the cause* of the rest of the bodies we see

about us. Rest is simply *the effect* due to a balance of the causes tending to set the body in motion.

5. **Common objection to the principle of inertia.** The second part of the principle asserts that if a body is moving at a uniform rate in a straight line, it will continue to move at the same rate and in the same direction, if no force intervene. It might be reasonably objected, that no such case is known of bodies continuing to move uniformly without some impulse; that all bodies do come to rest under such circumstances more or less quickly. Indeed, in former times, when the planets were seen to move in orbits nearly circular, and it was not known that there was an external force residing in the sun, constantly tending to draw them out of the straight line in which they were at each moment tending to move, it was asserted, even by Galileo, that all bodies naturally move at a uniform rate, but in circles, not in straight lines. How shall we encounter this objection? By showing, as we did before in the case of bodies at rest, that there is always in practice some force acting upon all bodies to alter their motion, but that the more we diminish the disturbing action of this force (both as regards its quantity and the deviation of its direction), the more do we approach to a state of uniform motion in a straight line. All boys know that a stone travels further, the smoother the ice; they may be led to infer that there is some friction even in the smoothest ice. They know that railway trains pull up with very different degrees of ease, especially on slippery days. Why does the guard of a railway train run along by the side of the train before he jumps into his break? Because he wishes to acquire the same velocity as the train, that, when he lights upon the step of his van, no external force may be needed to alter his velocity. Why should a man, when he alights from an omnibus in motion, be careful to alight with his face in the direction of the motion of the omnibus? Because the whole of his

body is still moving with the speed of the carriage, and, if the feet are suddenly stopped, the upper part of the body will still continue to move forward, and therefore, if the man alight with his back to the carriage, he will fall on his back. Even when he alights with his face in the direction of the motion of the carriage, he should allow his feet to rest on the ground as short a time as possible for the first few steps.

6. **Momentum of a body.**—Hitherto we have considered a body only in its relative position to other bodies; we will now consider its quantity of motion as compared with that of another moving body. It is evident that we must consider not only the rate at which each is moving, but also the mass or quantity of matter in each body; e.g. if two bodies are of equal mass, but the velocity of one is twice as great as the velocity of the other, the momentum of one would be twice as great as that of the other. A very heavy body would cause a much greater amount of mischief than a light body moving at the same rate. If we support different weights in either hand, the amount of effort required to project them with equal velocities is different. *In all cases of moving bodies, if we consider the effect produced, we must consider both the velocity and the mass of the bodies;* the momentum of two bodies may be compared by comparing the products of these two quantities expressed according to some settled standards.

7. **Masses of bodies compared by their weight.** In Chapter I. we determined our standard of velocity; it becomes necessary to agree upon some standard by which to compare the masses of bodies. Among all the sensible effects produced by the quantity of matter in a body, the most convenient for purposes of comparison is found to be its weight. What do we mean by the weight of a body?

8. **General law of gravitation.**—Before discussing the particular case of gravitation on the earth's surface, the

general law should be stated, viz., that *if we take any two bodies each of them attracts the other, and the force with which they attract each other increases with the quantity of matter in the two bodies, and with the nearness of the two bodies to each other.* A practical example of this is the manner in which two light bodies floating in water are attracted towards each other, or to the sides of the vessel. First give the simplest example of two globes of equal mass, and the class will easily see that each would have the same momentum, and that they would therefore move towards each other with equal velocities in a straight line, and would consequently meet halfway.

By diminishing the mass of one of the globes and increasing the mass of the other, it will be readily seen that the velocity of the larger globe will be the smaller. Further, if we suppose the mass of one much greater than the other, the smaller globe will fly to the other with a very great velocity, and the other will be very little affected.

9. **Attraction on the earth's surface.**—Apply the last case to a comparison of the earth's mass and that of bodies on or near its surface. Let the class understand that the mass of the largest mountain on the earth's surface is scarcely appreciable, as compared with the mass of the earth. What must be the effect of the earth's attraction on ourselves or on any of the small bodies on its surface? Evidently our attraction upon the earth is inappreciably small, but the earth's attraction upon each of us tends to draw us in a direct line towards the centre of the earth, and we are only prevented from moving by the resistance of the earth's surface to such a motion. In this way children may be led to understand the spherical shape of the earth, supposing it to have passed from a fluid to a solid state; the spherical surface of the sea; the use of the plumb-line as being true for each particular locality; the reason for the heads of our cousins in the antipodes being

turned in the opposite direction from our own. Such questions as our comparative weight on the earth and moon, or on the earth and sun or one of the larger planets, might here be introduced.

10. **Centre of gravity.**—We have seen that the weight of a body is caused by the attraction of the earth, which draws each particle of a body downwards with equal force in lines which may be considered parallel if we regard our immense distance from the centre of the earth. But as all the solid objects within our reach consist of a number of these particles rigidly bound together (i.e. so joined that the different particles are incapable of altering their relative positions), the weight of the whole body will be the weight of all the separate particles. Supposing such a body to rest on a single point, it is evident that some of the particles of the body will pull the body in one direction, others in other directions; and that if all these efforts exactly balance each other, the body will not be pulled down, but will stand. If a vertical line be drawn through this point, it will pass through a certain point in the body called its *Centre of Gravity.*

11. **How to find the position of the centre of gravity.**—In some simple cases it is easily determined. A glass sphere or marble will always remain at rest in whatever position it is placed; the centre of the marble is therefore the centre of gravity; a stick balances round its middle point; a juggler balances circular plates by supporting their middle points. Let the class try the experiment of suspending any heavy body of irregular shape by strings fastened to different points in the body, and they will find that the directions of all the strings produced pass through a particular point.

12. **Some common illustrations of the centre of gravity.**—A body will stand on a base so long as the verti-

cal line through the centre of gravity falls within the base. If we place an egg on its side and disturb it slightly, it will oscillate, but will return at last to the original position; *when, as in this case, a body returns to the position of equilibrium after being disturbed, the equilibrium is said to be* STABLE. If we place it on either of its ends and disturb the position of equilibrium, the egg will go further from the position and will not return to it; this equilibrium is called UNSTABLE. A cylinder standing on its base, if tilted up till the vertical line passing through the centre of gravity falls outside the base, will topple over; but any less degree or tilting will only cause the cylinder to oscillate and fall back at last to the original position of equilibrium. If a person running along encounter an unseen rope stretched across his path below his centre of gravity, he will fall on his face; if above, he will be thrown on his back; if exactly in the horizontal line passing through his centre of gravity, he will be suddenly checked. *If you wish to place an object in the best position of stable equilibrium, place it with its centre of gravity in the lowest possible position;* do not try to make an egg stand on either of its ends, without first cracking the end, as Columbus is said to have done, and giving it a practicable base to stand upon.

It may be also shown that an elastic string is equally stretched by a very heavy weight gathered into a small compass, and by the same weight distributed over the particles of a large body; from which it may be inferred that the weight of a body in equilibrium may be supposed to be collected in one single heavy point at the centre of gravity.

13. **Forces measured by weight.**—Forces may be compared with each other by means of any of the effects they produce, either by the motion they would generate, as in the case of a falling body, or by the resistance they are capable of overcoming, as when a weight overcomes the resistance of the spring in a weighing-machine. An old-

fashioned test of the muscular power of a man was the distance to which he could pull out a handle fastened to a strong spring. *But forces are generally measured by the weights they will lift.* We have already agreed upon certain units of length, time, and velocity, and we might take for our UNIT OF FORCE *that force which would cause a body of a given unit of mass to move through to one unit of space in one unit of time.* Thus taking one second as the unit of time, one foot as the unit of space, the quantity of matter in a grain of gold as the unit of mass, our unit of force would be that force which would cause a grain of gold to pass through one foot in the first second. But before agreeing upon the unit of force, we must know more about the acceleration or increase of velocity of bodies acted upon by a constant force.

14. **Accelerating force.**—Supposing the force to act for more than one second of time, we have now to enquire what would happen in the second, third, and each consecutive second. If a body is let fall from the top of a tower, it is found at the end of the first second to be falling at a rate that would carry it through 32 feet in the next second, at the end of the second and third seconds to be travelling at a rate of 64 and 96 feet per second respectively; in other words, the body receives each second an additional rate of 32 feet per second. Again, if it is thrown downwards with an initial velocity of so many feet per second, it is still found to acquire the same addition of velocity as before in consecutive seconds. A body therefore receives equal additions of velocity in equal times, whether it starts from rest or is projected in the direction of the force. Employing the before-mentioned units of time, length, and velocity, we shall call the accelerating force of gravity 32, because its additions of velocity in consecutive seconds are 32 times as great as those of a force that would produce an additional velocity of one foot in each second of time. It should be clearly

stated that, whether a body start from rest, or with a slow motion, or with a rapid motion, the same force will not produce greater or less velocity in one case more than in either of the others.

15. **Bodies thrown vertically upwards.**—It follows from the last statement that, if a body is thrown upwards, it returns to the place from which it was thrown with the same velocity with which it started, but in the opposite direction. If a stone is thrown upwards, gravity acts in the opposite direction to the motion of the stone; and whereas, in the case of a stone thrown vertically downwards, it accelerates the velocity, in the former case it diminishes it *by an exactly equal amount.* The whole velocity with which it started will be at last destroyed, and the stone will come to rest; it will then begin to fall, and whatever velocity was *taken off* in the last second of its rise will now be *put on* in the first second of its fall, and in consecutive seconds additions equal to the diminution of its rise will take place; so that the stone will return to the place of projection with the velocity of projection.

16. **All bodies do not fall to the ground with equal velocity.**—As bodies are made up of different particles, each acted upon by the same accelerating force, it does not matter, so far as the velocity is concerned, whether a body is composed of thousands of such particles, or of a few only. A bullet, a sheet of paper, a feather, should all fall to the ground in the same time; of course practically the lighter bodies are retarded by the resistance of the air upon their larger surface, a resistance scarcely appreciable for short distances in the case of a small heavy body. Experiments made with the air-pump prove that *if the air could be entirely removed, all bodies, whether light or heavy, of large or small surface, would fall to the ground in equal times.*

17. **Moving force.**—It is evident that when we consider the work that a body can do, the momentum or quantity of motive power it exercises, we must consider also the mass of the body. An apparently slight push of an ironclad is sufficient to tear open the side of the strongest ship; while the heaviest blow of a hammer, given ever so swiftly, will hardly make a dent in its side. It was supposed at one time that large heavy bodies ought of necessity to fall more quickly to the ground than small light ones; that a body twice as heavy ought to fall to the ground twice as quickly. It was forgotten that, to produce an equal amount of velocity in a heavier body, more force was required, and that a body twice as heavy requires a force twice as great to make it fall to the ground with equal velocity. We have already said that we know nothing of mass in itself, but that we can compare one mass with another by means of some sensible effect, and that the most practicable of these effects to deal with is the weight of a body. If, then, we take the standard pound as our unit of weight, and retain our former standard units of time, space, and velocity, what will be our standard of moving force? Evidently that force which, acting for a second upon a body whose weight is one pound, would produce a velocity of one foot per second. Now we know that the force of gravity, or a force equal to the weight of a pound, would produce upon the mass of that pound a velocity of 32 feet per second; our unit of moving force must therefore be $\frac{1}{32}$ of the weight of a pound, or half an ounce.

18. **Work done by a force.**—The common measure of work done by a force in mechanics is the amount of weight it can lift. The power of horses in drawing carts, of wind in turning windmills, of hammers in driving nails, can all be compared in this way by a common standard. The unit of work done is called the '*foot-pound*,' i.e. the raising of one pound through a space of one foot. We can compare

two forces by asking How many foot-pounds could each perform in a second or a minute, or any equal interval of time?

19. **Power of a force.**—The power of any force depends not only upon the amount of work done, but on the rate at which it has been done. The term *horse-power* applied to steam-engines rests upon the estimate of a horse's ability to raise a weight of 33,000 lbs. through a height of *one foot* in *one minute*; thus a steam-engine of 100 horse-power would be able to perform 3,300,000 foot-pounds of work per minute.

20. **Meaning of the term 'Energy.'**—Energy simply means the *power to do work*. It need not be exercised in producing motion (which is our common notion of energy), but it is always producing some effect, and, as we shall see hereafter, may be changed into a cause of motion. We have said before that it is a mistake to suppose that anything is in a state of perfect rest, i.e. not acted on by external forces. If a body is at rest, i.e. appears to us to be exercising no energy, it is really exercising some *energy of resistance* to friction, or wind, or some other moving force.

21. **Various forms of energy.**—We can compare the energies of different bodies by the amount of work of the same kind that they can respectively perform, e.g. in raising weights. But we may also say that a body lying on the ground possesses energy in calling forth an amount of resistance from the ground. If a hole were suddenly to be opened by the ground giving way beneath it, this energy of *resistance* to the ground would be changed into an energy of *motion*. If we throw a ball to the top of a cupboard, the energy of motion exerted in throwing the ball there is now converted into an energy of position; if the ball were to fall from that height, it would fall with the same vertical velocity with which it ascended.

Again, let us consider the energy of a body not acted on by such an external force as gravity, or by chemical forces, but only in relation to the particles composing its own mass. We may suppose that these particles exert force upon each other to preserve their relative positions, and are always in a greater or less state of tension. When we see that substances contract and expand with changes of temperature, or that their shape is altered by some violent external shock distributed among their particles, we infer that the energy exerted by the different particles in maintaining their former positions has undergone some diminution or increase. For example, if a body expands when heated, we may explain this change by supposing an increase of energy among the particles, necessitating a new position of the particles among themselves. When the heat is withdrawn from the body, and the transferred energy passes to some other body, we should expect the body to lose the energy of the new position it had acquired by virtue of the heat; the particles would return to their former energy of position, and the body would contract.

22. **Heat considered as a form of energy.**—We use the word *heat* with two different meanings—the sensation we experience when we touch anything hot, and the cause of that sensation in the object itself. The sensation is altogether relative to ourselves; we know that we should think what we call a cold day in summer to be a warm day in winter, and that the same hot water may present very different sensations to a laundress accustomed to the washtub and to our inexperienced hands. Let us put aside this sensation, and ask what we mean by the heat in the body which is the cause of the sensation. It is commonly thought now that heat is a particular state of energy, which produces a vibratory motion in the particles of the heated body; that this motion is so rapid as to be beyond the power of our eyesight to discern; that it is communicated to the par-

ticles of the air and then transferred to the particles of other bodies.

23. **Energy of heat transferred into other energies.**—Though the vibratory motion is caused by the energy of heat, it does not follow that the whole of the energy will be expended in producing heat in other bodies. *Latent heat*, as it is called, is merely the heat which is employed in altering the position of the particles of the body among themselves. For example, a block of ice exposed to heat will rise to a certain temperature, but will not rise beyond that temperature till the whole is melted; i.e. the energy of heat has been transferred into the energy of changing the ice into water. If we continue to apply heat, the temperature will again rise till it reaches boiling-point, when it once more becomes stationary, and the energy of the heat is now transferred into the energy of changing water into steam.

24. **Instances of the transference of other energies into heat.**—A light may be procured by rubbing two dry pieces of wood together; forests are set on fire by the rubbing of dry boughs together in a high wind; our forefathers obtained light by a flint and steel; saws and railway axles should be well greased, to prevent the energy of motion being changed into the energy of heat; grindstones are kept moistened, scythes sharpened, that energy may not be lost by its conversion into heat; even pieces of ice may be melted by violent rubbing.

25. **Standard measure of heat.**—We have before stated that all forces can be compared by the work required to raise a standard weight. Exact equivalent standards of the work required to produce heat and the work required to raise a weight have been determined. It is found that *it requires as much work, under ordinary conditions of the air,*

to raise the temperature of a pound of water by one degree, as shown in a common (Fahrenheit) thermometer, as would be required to lift a pound of water through a height of 772 feet; or, to use the common mechanical measure, it is equal to 772 foot-pounds.

26. **Transference of other energies.**—We have already seen in the case of heat that the energy of heat may be transferred in the same form of energy or in some other equivalent form. But the wider proposition is true, that *all energy lost by one body is acquired by some other in that form or in some other form.* This is commonly expressed, as regards quantity of motion only, in the following form: *Action and reaction are equal.* For example, if one perfectly elastic ball strike against another (disregarding the part of the energy employed in producing heat), whatever momentum is lost by one of the balls is acquired by the other. Again, when a ball is fired from a small cannon that runs freely on its wheels, the exploded powder acts equally upon the ball and the gun; but in the case of the ball the energy is almost entirely employed in producing motion, in the case of the cannon some part of the energy is employed in the action of the different particles of the cannon upon each other; the other part produces a comparatively small amount of motion, owing to the greater mass of the cannon. But, though exhibited in different ways, *the energies expended upon the ball and the cannon are equal.*

27. **Energy cannot be destroyed.**—Energy may be removed from the reach of our sensations, but is only stored up in the form of a different energy. The heat of the sun may cause the growth of vegetation, which may pass into coal, and the coal may be imprisoned for thousands of years, till the heat is released in our fires, to be transferred again into energy of motion in the bubbles that rise from the surface of

the kettle. The carbonic acid gas of the air may pass into the structure of plants, and be employed in the energy of growth, and may subsequently be released and exercise an energy of chemical union with other substances. Water may be pumped up from large reservoirs into mains and pipes, into an energy of position ready to be changed into an energy of motion by flowing into our cisterns. The blacksmith's lifted hammer, the wound-up spring of a clock, a tightened bowstring, are examples of potential energy which may be transferred immediately into energies of motion. We draw therefore this general statement regarding the forces of the universe: *Energy in all its various forms throughout the universe is constantly being transferred from one body to another, but is never lost; the actual total amount of energy is never increased or diminished, but remains always constant.*

28. **Transference of energies.**—It may be useful for the class to trace the transference of energies from one form to another on the following plan:—

Energy of position may be changed into energy of motion. A wound-up watchspring into the turning of the wheels, &c.

Energy of motion may be changed into (*a*) energy of position, as lifting a weight on to a table; or (*b*) into energy of separation of the particles of a body, as the stretching of an elastic band; or (*c*) into heat, as the heating of a railway axle; or (*d*) into some of these combined, as the forging of a horse-shoe; or (*e*) in producing electricity, as in rubbing a cat's back.

Energy of heat may be changed into (*a*) energy of motion, as in the steam of an engine, or (*b*) into energy of separation of the particles of a body, as a heated poker and melted lead, or (*c*) in producing electricity.

The same process might be employed for other energies, e.g. for electricity in the discharge of lightning from the clouds, for the various energies of destruction, &c.

CHAPTER III.

THE SIMPLE MECHANICAL POWERS. PRESSURE AS APPLIED TO LIQUIDS. THE PARALLELOGRAM OF FORCES.

1. **Friction.** — Before considering the mechanical powers, we will shortly notice some of the laws regarding friction, i.e. the rubbing or sliding or rolling of bodies against each other, inasmuch as this force practically exercises great influence in preserving the state of rest, or in retarding the motion of bodies. Of course no two bodies can slide or roll over each other without some resistance, though this resistance is reduced to a minimum in the case of very smooth ice, of greased wheels, &c.

The chief experimental laws about friction are :—

(1) It is greater when two surfaces of the same kind are rubbed together than when either is rubbed against a surface of another kind.

(2) The same substances always exercise the same resistance of friction.

(3) The heavier the pressure is, the greater is the friction.

(4) The friction is not greater, however the surfaces in contact increase, if the pressure does not alter. When one body rolls on another, it is observed that the friction is very greatly diminished, especially if the rolling body be of very large diameter. The friction of the axle of a wheel pulley is intermediate between sliding and rolling friction.

As an example of (1), it is found that if a block of ice weighing 100 lbs. be pushed on ice, the resistance would

be equal to a force of 3 lbs.; if the block were of steel, the resistance would be only $1\frac{1}{2}$lb.

2. **Friction, want of rigidity, and flexibility disregarded.**—In all machines which involve ropes, smooth surfaces, strong rods or bars, in practice the ropes cannot be made perfectly flexible, the surfaces perfectly smooth, the bars and other parts perfectly rigid or unbending. Machine-makers aim at satisfying these conditions so far as they are reconcilable with other necessary qualities of the parts of the machine, and in our theoretical consideration of the following mechanical powers we will suppose this object so far gained, that we may disregard defects of machines; and assume that a body will roll or slide freely, that our ropes will bend with the slightest push in the direction of their length, and that no part of our machines will bend or alter its position relatively to other parts.

3. **The lever.**—This consists of a rigid rod which moves about one point on which it is supported, called the *fulcrum*, the parts of the rod on either side the fulcrum being called the *arms*. It is acted upon by weights depending from it or by pressure applied to it. As levers are commonly used for lifting weights, it is usual to speak of the lever in its simpler form as acted upon by two forces which are called respectively the *power*, or that which raises, and the *weight*, or the resistance to be overcome.

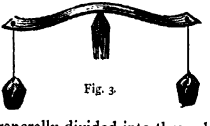


Fig. 3.

Levers are generally divided into three classes:—

(1) Those in which the fulcrum is between the power and the weight, as in a seesaw, or a crowbar, or a pair of scissors.

(2) Those in which the weight is between the power and the fulcrum, as in a wheelbarrow, nutcrackers, trap-doors.

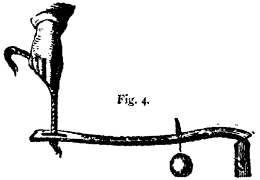


Fig. 4.

(3) Those in which the power is between the fulcrum and the weight, as in a knife-grinder's treadle, or a pair of shears or tongs. The limbs of animals are levers of the last kind: e.g. if we wish to lift our forearm, the socket of the elbow is the fulcrum, a muscle attached to it near the socket is the power, and the weight of the limb and of the body carried in the hand (if any) is the resistance to be overcome.

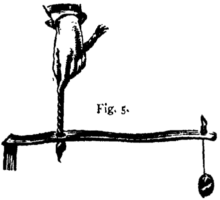


Fig. 5.

If we employ for illustration of the first class of levers a rod resting on a fulcrum between the two weights (fig. 3), and of the second and third classes a rod turning round a hinge at one end, which has a weight depending from one point of the rod, and substitute for the power of the hand in

the preceding diagrams the tension of a rope which passes over a peg and supports another weight, we can prove by actual weight and measurement that:

(*a*) The power and the weight are to each other in the inverse ratio of their respective arms: i.e. we require the less power as we increase the arm at which it is applied.

(*b*) They are to each other inversely as the spaces they respectively describe, if we suppose the lever to turn round the fulcrum, and the power and weight to move each through a certain space: i.e., if we gain increase of power by increasing the arm, we lose in velocity, or, as it is often stated, *what we gain in power we lose in time.*

4. **Virtual velocities.**—The principle of virtual velocities may be stated in popular language: 'What we lose in power we gain in time.' In the last paragraph the principle was shown to hold good in the case of the lever; but it may be stated more generally of all attempts to do work: if we wish to save time, we must lose power; if we wish to gain power, we must lose time. When we take any body, having a fixed point of support, and kept in equilibrium by two forces, which tend to twist or pull or push it in opposite directions, and give a very slight motion to the body round the point of support, it will be found that the motion of the point at which the greater force is applied is less than the motion of the point at which the lesser force acts. The common screw, a pump-handle, or a bricklayer's windlass, will supply useful illustrations. The class should be led to see that for a given weight the spaces which must be described by the power required to lift it, and by the weight itself, will be a practical guide to the power required.

5. **Wheel and axle.**—This machine consists of two wheels or cylinders having a common axis, joined so as to

form one solid piece, or cut out of the same piece; the smaller cylinder is called the *axle*, the larger the *wheel*. The axle extends beyond the wheel and at right angles to it. The weight is suspended by a rope which is coiled round the axle. The power is applied in various ways, sometimes by spokes protruding from the wheel, sometimes by a cord coiled round it.

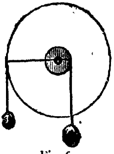


Fig. 6.

The principles to be mastered by the children are :—

(1) When the machine is in equilibrium, the ropes might be supposed to be nailed respectively to the wheel and axle, and the machine would then represent a lever of the first order.
(2) In this state of equilibrium, as in the lever, the power is to the weight as the radius of the axle is to the radius of the wheel.
(3) When we overcome the weight by applying a greater power, we keep bringing into play an endless succession of levers, e.g. in raising a bucket out of a well, as in fig. 7.

Another common illustration of this machine is the use of a windlass for raising materials to the upper story of a house; but it should be explained that the continuing of the rope which supports the weight over a pulley merely alters the direction of the resistance to be overcome, and not its amount. Overshot and undershot wheels in a mill stream may be also explained.

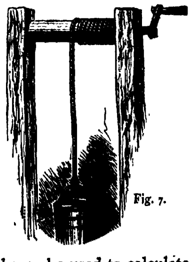


Fig. 7.

The principle given before, 'What is gained in power is lost in time,' may be shown to be true of this machine also, and may be used to calculate

the amount of power required to raise a weight on the differential windlass. In this case the axle consists of two cylinders of different thicknesses, forming one rigid piece with each other and with the wheel. The rope is coiled round one of these cylinders in one direction and round the other in the opposite direction, so that when one coils the other uncoils, and the weight, which is fastened to a pulley resting on the rope between the two coils, rises by half the *difference* between the circumference of the two axles in the course of one revolution. It follows from the principle of velocities that the ratio of the power to the weight in this case is as half the difference of the circumferences or radii of the axles to the circumference or radius of the circle described by the handle at which the power is applied.

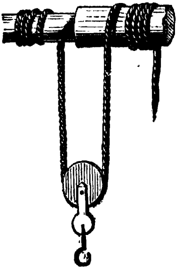


Fig. 8.

Some notice may be taken of the transference of motion by means of bands and of toothed wheels. When pulleys are driven by belts, we gain increase of velocity in the axle joined to the smaller wheel. If the belt crosses between the two pulleys, they will turn in opposite directions; if it does not cross, in the same direction. In like manner the action of toothed wheels, as in watches and clocks, should be explained generally as a transference of motion from one wheel and axle to another, and the difference of motion of the hour, minute, and second hands of watches may be explained.

6. **The pulley.**—The pulley consists of a wheel, able to turn about its axis, which is either fixed or moveable. A groove is cut in the circumference of the wheel, in which a rope passes, being prevented by friction from sliding. The axle is supported by a box called the *block*.

The simple pulley by itself, if its axis is fixed, serves only to change the direction of the application of a force or of

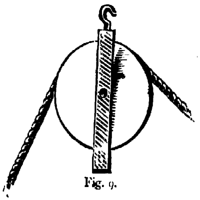


Fig. 9.

the motion, as when a labourer lifts a scaffold-pole to a higher story by a rope passing over a fixed pulley.

If the axis is not fixed, but moveable, and the pulley is supported by the cord, one end of which is attached to a fixed point (fig. 10), the pulley may be considered as a lever kept in equilibrium by equal tensions on each side, which are together just sufficient to support the weight; each of these tensions, therefore, is equal to half the weight. It is easily seen that as the power is lowered through a certain distance, the weight is raised by no more than half the same distance, and the principle of 'velocity being lost in the same proportion as power is gained' holds good.

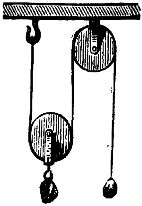


Fig. 10.

We will apply the principle to other systems of pulleys, assuming that the advantage gained by any system may be calculated by comparing the velocity of the power with the velocity of the weight.

In two blocks, the lower of which is moveable and the upper fixed, both containing the same number of pulleys (fig. 11), let the same string pass through all the pulleys, and let the strings be

parallel to each other. If we suppose the weight which depends from the lower block to be raised through a certain space, it is evident that all the strings will be shortened by the same quantity, and consequently the power will be moved through a space equal to the shortening of all the strings: e.g. if there are eight strings or four pulleys, the power will be moved through a space eight times as great as the weight; or the power is to the weight in the ratio of 1 : 8.

In the system of pulleys where each string is fastened by

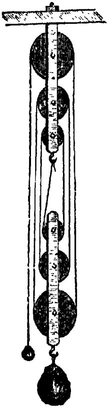


Fig. 11.

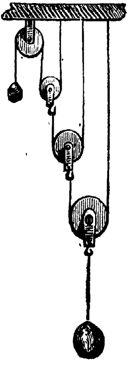


Fig. 12.

one end to a beam, and the other end of each to the axis of the pulley just above (fig. 12), if the weight which depends from the lowest pulley is raised through a certain space, the second pulley, i.e. the pulley next above, rises through twice this space, the third pulley through four times, the fourth pulley through eight times this space, &c. If there are six pulleys, the power will descend through thirty-two times the

space that the weight ascends, and the power will be to the weight in the ratio of 1 : 32.

In another system, where all the strings which pass over the pulleys are attached to the weight, it may be shown that if the weight is raised the highest moveable pulley falls through the same space, the second pulley through twice the space, the third pulley through three times, the fourth pulley through seven times, and so on.

In these complicated systems of pulleys it is found in practice that the stiffness of the string and the roughness of the surfaces are great hindrances to work.

7. **The inclined plane.**—This represents a level surface, supposed to be perfectly smooth, tilted up so that a body can slide down it freely without friction. Applying the principle of virtual velocities, we see that if the power be applied to a weight resting on the plane by means of a rope passing over a pulley at the top of the incline, and be supposed to move downwards through a small space, the vertical space through which the weight will ascend will be found to bear to the space through which the power has descended the same ratio that the height of the plane bears to its length.

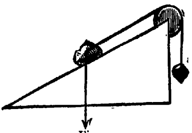


Fig. 13.

Two interesting properties may be noted:—

(1) If a body slide freely down an inclined plane, the velocity acquired by sliding down the length of the plane is equal to the velocity that would have been acquired if the body had fallen through the same vertical height.

(2) If chords be drawn in a circle standing in a vertical plane from the lower end of its vertical diameter to any point in the circumference, all bodies started at the same moment down these inclined planes would arrive at the foot of the diameter together.

8. **The wedge.**—The common form of the wedge needs no description. In practical use the wedge is driven downwards with considerable violence, and the friction at the sides is greatly diminished by the vibration of the shock. The wedge may be considered as a form of lever, the *power* being transmitted by the blow to the point in which the wedge

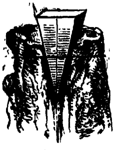
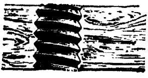


Fig. 14.

is in contact with the sides of the object, the *resistance* to be overcome being the rending fibres, and the *fulcrum* being some point beyond. We may also suppose the wedge to be a case of a double inclined plane, the pressure on either side of the wedge being counteracted by a weight on the head of the wedge. It was seen in the case of the inclined plane that the power bore to the weight the ratio of the height of the plane to its length. It follows therefore that *the thinner the wedge is, the greater is the power*; but when the wedge is diminished in thickness the tool loses in strength. Chisels and nails may be considered as particular modifications of the wedge; a pair of scissors may also be considered as a case of a wedge, the substance to be cut presenting the same resistance as to a wedge inserted.

9. **The screw.**—This power consists of a spiral ridge traced upon a cylinder so as to be inclined everywhere at



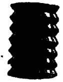


Fig. 15.

the same angle to the horizontal plane. This cylinder fits into a hollow cylinder, having a groove which exactly fits the thread. If we suppose the screw to descend under the action of a weight placed upon the head of the screw, the screw will descend spirally, unless it be resisted. Now let us suppose the resistance, which we will call the power, applied at the end of an arm which projects from the screw. Applying the principle of virtual velocities, we see that if the weight were

allowed to descend by the vertical distance between two threads, the resistance or power would have moved through a complete circle; the power, therefore, will bear to the weight the same ratio that this vertical distance bears to the circumference of the circle described by the power.

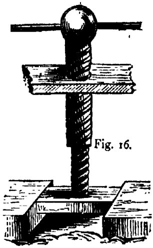


Fig. 16.

We see, therefore, that advantage is gained by diminishing the distance between two threads, but the strength of the screw is diminished thereby. To remedy this, a differential screw, similar in principle to the differential windlass, has been invented; this machine consists of two screws of unequal fineness, one of which ascends while the other descends, so that in one revolution the weight descends by the difference of the vertical heights between two threads of each screw, and though the machine moves slowly, great strength is gained.

We are all familiar with the use of the common screw for fastening pieces of wood or metal together. The friction of the screw against the other substance is sufficient to prevent it coming unscrewed when it has been driven home. This friction is greatly diminished by the vibrations of machines, and in this case the screw is liable to be loosened.

The screw of Archimedes consists of a tube wound round a cylinder like a screw. Let this screw be tilted up so that the axis of the cylinder makes with the horizontal line an angle equal to that which the spiral makes with the horizontal plane. It will be seen that when the screw in this position is at rest, a part of the tube is parallel to the horizon. If a grain of corn be placed in the horizontal part and the screw turned, the grain will ascend in the tube, because the part of the tube in which it was lying is now higher than the part which was above it, and by degrees will be brought to the top of the tube.

10. **Liquid pressure.**—It was shown for the first time, two hundred years ago, that, if a liquid be enclosed in a close vessel and pistons or sliding plugs of equal area be introduced at different parts of the vessel, a force applied at one of the pistons will require an equal force to counterbalance it at each of the others; if the area of one piston be twice as great as that of the other, a double force will be required at the larger piston. It was inferred from this that the pressures on any two such pistons would be proportional to the areas of the pistons. It follows that a pressure exercised upon any part of a fluid is transmitted equally in all directions throughout the fluid.

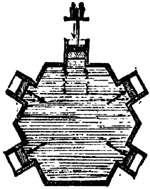


Fig. 17.

11. **The common pump.**—The action of the common pump depends upon the principle of liquid pressure above stated. If we place a hollow tube vertically with one end below the surface of the water, the water both within and without feels the pressure of the air; for air, like all other sensible things, has weight, and the whole of our globe supports a pressure due to the air, equal to a weight of 15 lbs. to the square inch. If we suppose the pressure removed from the water within the tube, but still acting upon that without, this latter pressure will be transmitted throughout the water, and will pass to the water within the tube. As there is now no downward pressure on this surface, the water will be pushed upwards, and will rise in the tube. The old ex-

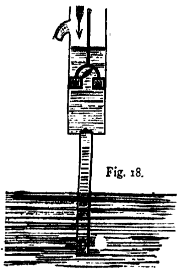


Fig. 18.

planation, 'Nature abhors a vacuum,' which meant that directly a void space is made it must be filled up, is found to be untrue when the water has been raised to a height of 34 feet.

The same principle of liquid pressure would apply to the action of sucking up liquids when we drink, and, if we extend it to gases, to the action of breathing, to the draughts under our doors, and to winds generally.

12. **Hydrostatic paradox.**—This term expresses the following principle: that in theory the smallest quantity of water may be made to balance the heaviest weight, or to produce a pressure sufficient to burst the strongest reservoir. For example, a closed reservoir below the level of the ground may be filled with water by a sudden thundershower; if a closed pipe leading from the roof of a house into it be also filled with water, the pressure caused by the weight of the column of water in the pipe is distributed everywhere throughout the water in the reservoir, and presses with great force on the sides and top. It frequently happens in such cases that the top (an arched dome or flagstone) may be unable to support the pressure, and may 'blow up.' In the same way pressure is distributed throughout a body of air and gas. If a closed roof is placed upon a house before the windows are filled in, a gust of wind may enter, and the pressure being distributed over the roof may cause it to lift. A garden frame may also be lifted by a slight gust, if not carefully closed.

13. **Hydrostatic press.**—Another example of the same principle, or paradox as it was called, is to be found in the hydrostatic press, the common form of which, now brought into general use, is called Bramah's Press. In this press a strong piston of small diameter is pressed down on the surface of water enclosed in a strong reservoir; another strong piston of much larger diameter supports the weight

to be raised or the substance to be compressed. It is easily seen that if the small piston has an area equal to only one-hundredth part of the area of the large piston, any pressure produced by pressing down the smaller will produce a pressure one hundred times as great upon the larger piston. The chief use of this press is to reduce the bulk of light substances, e.g. to compress trusses of hay and bales of cotton, or to extract oil from seeds.

14. **Level surfaces of fluids.**—Let us now consider the case of a liquid, as water, not enclosed in a vessel, but with its surface exposed to the air. The pressure produced by the weight of the air acts equally upon each point of the surface. It can be easily shown that the surface of the fluid must be horizontal. If we take two points in the same horizontal plane in the fluid, and suppose that one of these points could be eight inches and the other six inches below the surface of the water, at the first point there would be a pressure equal to the pressure of the air *plus* the pressure due to a depth of eight inches of water; at the second the same pressure of air, *plus* a pressure due to six inches only of water; whereas, as pressure is transmitted equally in all directions, the pressures in the same horizontal plane must be equal. It is evident, therefore, that, as every particle in the same horizontal plane must be subject to the same pressure, their distances from the surface of the water must be equal, or the surface of the water must be horizontal.

15. **Aqueducts, syphons, artesian wells.**—This property of liquids, viz. that the surface must always be horizontal at all points of a fluid whose parts are in free communication, has been employed in convenient methods of conducting liquids to considerable distances. In the case of closed aqueducts it is not necessary to maintain the same level; if a series of pipes be laid down the

slope of a hill, the water flowing down will rise to the same level in a series of pipes on the opposite slope. A reservoir constructed on a hill above the level of the highest houses of a town will therefore supply water to their roofs. Artesian wells, again, rest upon the principle that a large storage of water takes place in unseen reservoirs, which exist in some of the surrounding hills above the level of towns; if a shaft be made to pierce this reservoir, the water will rise to the level of the highest point of the reservoir, disregarding the resistance of the air. Fountains are an example of the same principle. Syphons, or bent tubes, are made available for emptying vessels, by immersing the *shorter* leg of the tube in the liquid, and providing that the end of the *longer* leg, outside the vessel, shall be below the level of the surface of the liquid.

16. **Solids floating in liquids.**—If we suspend a glass ball by a string in a liquid, it will take the place of the same volume of water, and as this water was in equilibrium under the pressure of the surrounding water, that pressure must be equal to the weight of the volume of water displaced.

Again, if we allow a wooden ball to float in water, it is evident that the weight of the ball is supported by the pressure of the surrounding water, but the weight of the water displaced was supported by the same pressure; the weight of the ball must therefore be equal to the weight of the water it has displaced.

Again, place a ball in a liquid of the same density as itself; it will float in whatever part of the liquid it is placed, as its weight is equal to the weight of the water it displaces. An egg will sink in water, but if we saturate the water with salt it will float, as its density is now less than that of the water. We can add just as much salt to the water as will make its density equal to that of the egg, and the egg will then float in any part of the liquid. A man floats in water because his

density is less than that of water, until his lungs are filled. A body heavier than water loses so much of its weight as is equivalent to the weight of the water displaced by the body. A body lighter than water loses weight in the same way; all who have swum in the sea know the ease with which the waves toss our bodies.

17. **Swimming.**—We are lighter than water, and float with a certain portion of our bodies not immersed. If by the action of our limbs we raise ourselves above the natural level of flotation, we afterwards fall below it, and we go through a series of oscillations, upwards and downwards, till we return to the original state of equilibrium.

18. **Liquids floating in other liquids.**—It is familiar to all of us that light oily liquids float on water in patches; and if we stir oil and water together in the same vessel, we find that every drop of the oil will gradually find its way to the surface of the water. On the other hand, if we shake up quicksilver and water in the same vessel, every drop of quicksilver will almost immediately find its way to the bottom. The same would happen if we experimented with the three liquids in the same vessel; they would be found to lie in layers, the quicksilver, being of greatest density, at the bottom, the oil, of least density, at the top, and each layer would be horizontal. The horizontal surface of each layer is a consequence of the principle of equal transmission of pressure throughout liquids, the weight of each particle acting vertically. It is possible with very great care, especially if the oil is of a viscous nature and clings to the sides of the vessel, to form a layer of another liquid of greater density on the top of a layer of oil which has settled into a position of equilibrium; but this position of unstable equilibrium may be easily disturbed.

19. **Flow of liquids.**—It has been ascertained by experiment that the velocity of a liquid issuing from a hole pierced in the walls of a vessel is entirely independent of the

nature of the liquid, and is equal to the velocity that would be generated in a body falling through the vertical distance measured from the surface of the liquid to the hole. Experiments upon the shape of a liquid stream issuing from a round hole show that the liquid does not flow out for any distance in a cylindrical form, but contracts at first for some little distance, and after a certain small contraction flows on in a smaller cylinder. Why should the flow contract at first and afterwards become even? The particles of water nearest to the sides of the hole suffer some amount of friction, and are compelled to move a little slower than the particles in the centre of the flow. But after they have moved on for some little time this retardation is counteracted by the power of adhesion of the various particles with which they are brought in contact as they glide past, and by degrees these outside particles resume their former rate of motion. When a liquid, as water, is required to flow for miles along a series of pipes, some of which, perhaps, may be placed at considerable angles, the disturbing effect of the sides of the pipes materially affects the flow of the liquid.

20. **Falling water.**—If we take a sheet of paper and move it rapidly across a thin falling column of water, we shall find, not one continuous even line of wet, but an uneven row of blotches. The column is therefore formed by a rain of liquid drops chasing one another without touching, and drops of different sizes encounter the paper in its passage across the column. But these drops do not keep the same shape throughout their fall; they pass through several changes: at first flattened horizontally like a turnip, gradually becoming almost spherical, and then drawn out vertically like a pear, after which they return in the inverse order to their original horizontally flattened shape. This change in the form of the large drops of the falling column produces a corresponding change in the circumference of the column. When the drops are flattened horizontally, the column is

wide; when vertically, it is narrowed. We shall see the reason of this, if we watch drops falling from a very small opening; each drop is retarded at the sides by the attraction of the small hole, it forms into the shape of a tear, and at last drops. The mutual attraction of the particles of the drop tends to make it assume a spherical shape, and it oscillates through the spherical shape to the flattened shape, and back again through the spherical shape to the tear shape.

21. **Flow of solids.**—We have before alluded to the interchange of the three states of matter under various conditions of pressure, temperature, &c., the commonest example of which is the change of ice into water and subsequently into steam. It can be shown, also, that the flow of solids under great pressure resembles the flow of liquids; but while gravity alone is sufficient to create a flow of liquids, it requires immense pressure, such as a punching machine under steam power, to create a flow of solids.

22. **Parallelogram of velocities.**—We have shown before that if an additional impulse be given to a moving body in the same or in the opposite direction to its motion, the body will move with a velocity equal to the sum or difference of the two velocities. Let us now consider the case of a body in motion receiving an impulse which would impart to a body at rest a velocity in a direction inclined at an angle to the direction of motion of the moving body. For example, we are in a railway carriage moving at the rate of 10 feet per second, and we throw a ball across the carriage with an equal velocity in a line from one window to the other. The ball was moving at the rate of 10 feet per second in the direction of the train, and has received an additional velocity of 10 feet per second in a direction at right angles to this motion: in what direction and with what velocity is it actually moving? Let us represent the ball's two velocities by two equal lines drawn at

right angles to each other: how shall we represent the resultant velocity? As the velocities are equal, there is no reason why the ball should be more influenced by one than the other; i.e. it must move in a direction equally inclined to both, or in the direction of the diagonal of the square constructed upon those lines.

Again, to return to our railway carriage, we find that the ball has travelled across the carriage exactly as it would do if the carriage were at rest; i.e. it would be found at the end of the diagonal. This diagonal must therefore represent, both in direction and velocity, the actual motion of the ball.

But we might vary the direction and velocity in which we throw the ball, and it would still be found at the end of the second to have travelled across the carriage as if the carriage were at rest; we may infer, therefore, in this and in similar cases, that the diagonal of the parallelogram constructed upon two lines representing the two velocities both in direction and magnitude will represent the actual resultant velocity both in direction and magnitude.

23. **Path of a projectile.**—Let us now suppose that one of these velocities receives regular additions at equal intervals of time, e.g. is doubled, trebled at the end of each second of time, what will be the path of the moving body? We shall have a succession of parallelograms, whose diagonals will form a chain, each diagonal coming nearer in direction to the direction of the increasing velocity. If the intervals of time at which these additional impulses are received be diminished, the links of the chain become smaller, and at last so small as not to differ sensibly from a curve line, if the intervals of time are indefinitely diminished. Now this is the case of an accelerating force, constantly adding small increments of velocity. We may therefore represent by a curve the path of a body, started with a certain velocity and acted on by a constant force in some other direction. If a stone be thrown in any direction except the vertical,

it will move in a curve under the action of gravity; and it may be easily shown, by carefully drawing such a succession of parallelograms as that above described, that the stone will fall to the ground in exactly the same curve as that in which it rose.

24. **Parallelogram of forces.**—A similar proposition to that stated before in the case of a body impelled by two velocities, differing in magnitude and direction, may be shown to be true also of a body kept at rest by the action of three forces; viz. if two of the forces be represented in magnitude and direction by two lines, the diagonal of the parallelogram constructed upon these lines will represent both in magnitude and direction their resultant effect, and the third force must therefore be represented by the diagonal in magnitude, but acting in the opposite direction.

The following will be found an interesting experiment.

If we suspend two weights connected by a string over two pegs, and from the string between the two pegs suspend another weight, less than the sum of the other two, it will be found that the suspended weight will rest in such a position that the three weights may be represented *in magnitude* by the lengths of string between the pegs and the point of suspension of the third weight and the diagonal of the parallelogram constructed upon those lengths. It is evident also that these lines represent the three forces *in direction* at the common point at which they produce equilibrium. If the weights are in the ratio of 3, 4, 5, and lengths of 3 and 4 inches be measured along the strings, the diagonal will be found to be vertical and equal to 5 inches; i.e. it will represent the third weight in direction and magnitude. This experiment may be varied at pleasure; care should be taken to prevent friction at the pegs, and to have a flexible string.

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ANIMAL PHYSIOLOGY.

CHAPTER I.

CLAIM OF HUMAN PHYSIOLOGY TO ATTENTION.

1. **Past neglect and present prejudice.**—No one science is of more value to us as human beings, perhaps none is of so great value, as Physiology, when we consider of what that complicated sum-total which we call 'human happiness' consists. Yet no science has received less attention in the past, and against none is there so great prejudice in the present. These two facts, taken together, however, give little or no cause for regret. The past universal neglect sprang of ignorance of the subject, strengthened and maintained by that preference of the ornamental before the useful, so characteristic of mankind; whilst the present contention marks the second stage in the growth of all human knowledge, that of enquiry. We may, therefore, logically look forward in the future to a period when unanimity will once more be established, but the unanimity of regard, not of disregard.

The existing prejudice against Physiology lies, not in its truths, but in the way and spirit in which those truths have been propounded: in other words, the origin of the prejudice must be sought, not in the science, but in certain exponents of that science. The disappearance of this pre-

judice, therefore, is only a question of time, and he will do good service who shortens that period.

2. Its rational claim.—Nothing would seem more rational than that human beings should be prepared for 'the battle of life' by being carefully taught all that is certainly known of the nature and use of the weapons with which that fight must be fought. Indeed, if the question were to be settled by reason, and reason only, there could be no doubt of the decision. 'The proper study of mankind is man.'

Who would hope to become a mechanic without serving an apprenticeship, during which he would acquire such special knowledge of the materials with which he worked, and of their properties, as would enable him to turn them to profitable use? Yet human beings are supposed to be fitted for life by an education that finds in it no place for Physiology! Our youths are expected to become acquainted with, at least, the outlines of the geography of their native land, and some knowledge too of their race is expected :—room can be, and is, found for geography and history, but none for Animal Physiology! To know anything of the landmarks of one's own system, or how the simplest and most necessary function of the body is discharged, or the history of any secretion, however frequent and important its use, is deemed quite unnecessary by the great mass of both parents and teachers.

An engineer must know something of a steam-engine, and of the physical laws in virtue of which it does its work, yet men and women are supposed to be able to educate children without knowing anything of the structure of those children, of the laws of human life, of the order in which human powers are developed, or of the nature and uses of those powers.

Now, although *habit* and *fashion* are stubborn opponents, yet this state of things brings such abundant disastrous consequences, and is so irrational, that it cannot continue. Ere

long it must certainly be demanded of all who claim the title 'TEACHER,' that they shall know something of the human subject whose development they are to aid, and whose future welfare, both in this world and the next, depends to so large an extent upon the treatment received at their hands.

3. Consequences of neglect of Physiology.—Let us glance at some of these disastrous results. We shall find them everywhere; in our homes and in our schools; affecting teachers and parents, as well as children.

We value wealth; we value power; we act as though we did not value life and health. We take great pains to secure the former, the latter are disregarded. Yet what would one give for health when gone, and how little, given at the right time, would save it! Often the most trifling physiological knowledge would have saved health irreparably ruined, and have handed on to children unimpaired constitutions.

Our children are not cared for nearly so well as many other of our worldly possessions. This is mainly because we make no more effort to understand child-life than we do to understand our own.

(a) *Intellectual.*—A little thought will show that the laws of life must underlie all bodily and mental processes, and a knowledge of them must therefore be of the highest importance. In spite of this the school-life of a child has been almost wholly artificial, being hedged about in all directions by fences and notice-boards giving warning that 'trespassers will be prosecuted.' These barriers and prohibitions were frequently placed directly across natural paths, for example, across that *childish inquisitiveness and restless activity*, which by those 'gateways of the mind,' the senses, open so soon communication with the external world.

During the last few years many of these fences have been rooted up and notice-boards removed, and so school

life has become much more natural and, therefore, more healthy and moral than it was; but before all these artificial restraints can disappear the laws of physiology and of psychology must be more perfectly known and acknowledged than at present, both by parents and teachers. School life must be an unbroken and unchecked continuation of those first and wonderfully successful five or six years of child life that give a language and no mean acquaintance with natural objects and natural phenomena.

Ignorance of the laws of life leads us to thwart much natural child effort after knowledge, often at the cost of a large expenditure of effort on our part. So there is a double loss of energy, a loss both on the side of the child and on that of parent or teacher.

(b) *Physical.*—And not only in this direction is evil being wrought, but physical ill-consequences are wofully abundant. The seeds of future life-long weakness or disease have frequently been sown in a dirty, ill-ventilated, imperfectly warmed, badly lighted, inconveniently seated, and wholly unadorned schoolroom; or have originated in studies too prolonged, too little broken or relieved, or undertaken too soon after a heavy meal, at a wrong age, or under wrong conditions; or have proceeded from improper methods of work, or still more improper modes of punishment. Herbert Spencer [1] says:—

'If any one doubts the importance of an acquaintance with the principles of physiology as a means to complete living, let him look around and see how many men and women he can find in middle or later life who are thoroughly well. Only occasionally do we meet with an example of vigorous health continued to old age; hourly do we meet with examples of acute dis-

[1] *Education: Intellectual, Moral, and Physical.* By Herbert Spencer.

order, chronic ailment, general debility, premature decrepitude. Scarcely is there one to whom you put the question who has not in the course of his life brought upon himself illnesses which a little information would have saved him from. Here is a case of heart disease consequent on a rheumatic fever that followed reckless exposure. There is a case of eyes spoiled for life by over study. Yesterday the account was of one whose long-enduring lameness was brought on by continuing, spite of the pain, to use a knee after it had been slightly injured. And to-day we are told of another who has had to lie by for years because he did not know that the palpitation he suffered under resulted from over-taxed brain. Now we hear of an irremediable injury which followed some silly feat of strength; and, again, of a constitution that has never recovered from the effects of excessive work needlessly undertaken. While on every side we see the perpetual minor ailments which accompany feebleness.'

(c) *Moral.*—Moral ill-consequences are equally numerous in any system of education that does, or attempts, violence to the laws of life. Those artificial fences could not stop all; some, and those of the best, would be irresistibly compelled to get *over* or *under* them, and with what damage to their morals is easily conceived. In fact, the moral results, under such circumstances, must necessarily parallel the physical.

The extent of all these evils, physical, intellectual, and moral, can scarcely be exaggerated. Physiology supplies the remedy so urgently needed.

4. Partial acknowledgment of claim.—Happily schools and school life have, of late years, lost much of their

artificial character. Thus commodious, neat, and cheerful schoolrooms have been built in accessible places; they are well ventilated, well warmed, and well lighted; convenient seats and desks have been provided, even blinds may be seen to schoolroom windows, and pictures, casts, and flowers on their walls and shelves; playgrounds are attached; a time-table, that secures frequent changes, a rational arrangement, and suitable breaks in the work, has to be approved by Her Majesty's Inspectors; singing and drill have found a place in school work; and, lastly, teachers are placed at the head of each school, who have not made teaching a 'dernier ressort,' but a settled purpose of life from the first, and have in many cases learned something of Human Physiology.

Still, education can never be what it ought to be, until teachers themselves know and fully appreciate those biological laws that alone can provide a solid foundation for any true method of education. The art of teaching must be founded directly on the science of life. Therefore all teachers should have, at least, a knowledge of the elements of Animal Physiology, and in training colleges the school management lectures should include a short series on the leading principles of psychology.

5. Practical value.—Besides the improved national health and happiness that must come from a wide-spread though elementary knowledge of the general laws of health, the value of cleanliness, and the evils of dirt and vice, the necessity of pure water and fresh air, of bodily and mental exercise, and the advantages of a temperance which is exercised in all directions—besides all this a knowledge of physiology is also of direct practical value in many of the accidents of life. How many persons have bled to death or been drowned before medical assistance could be obtained, whose lives could easily have been saved by one who had only a very elementary knowledge of the circulation of the blood, or of the true nature of respiration.

6. Relation to general education.—Education, whatever form it takes, has for its purpose the preparation of its subjects for complete living; and entire success in all directions cannot be reasonably expected from any scheme that does not include Animal Physiology. Again to quote Spencer:[1] 'How to live is the essential question for us. Not how to live in the material sense only, but in the widest sense. The general problem which comprehends every special problem is—the right ruling of conduct in all directions under all circumstances. In what way to treat the body; in what way to treat the mind; in what way to manage our affairs; in what way to bring up a family; in what way to behave as a citizen; in what way to utilise those sources of happiness which nature supplies—how to use our faculties to the greatest advantage of ourselves and others—how to live completely? And this, being the great thing needful for us to learn, is, by consequence, the great thing which education has to teach. To prepare us for complete living is the function which education has to discharge, and the only rational mode of judging of an educational course is to judge in what degree it discharges such function.'

(a) *Of Everybody.*—By no other study than that of the sciences, and by no one science so well as by physiology (including psychology), is this function fully discharged. In every aspect of human life it exercises great influence, directly or indirectly, from the pursuit of the earliest art, agriculture, to the 'Fine Arts,' sculpture and painting: so, in every stage in the progress of any one human life, it equally has a most important bearing; on the child, the youth, the young man, the father, the citizen.

(b) *Of Teachers especially.*—It has been said that a 'true philosopher' alone can be a *good* teacher; and there is so much truth in the saying, that the office of a teacher,

[1] *Education: Intellectual, Moral, and Physical.* By Herbert Spencer.

if rightly discharged, should be esteemed as most honourable by society, and by himself as of the highest importance. When the sciences of physiology and psychology shall have become perfect, then we may look for a perfect scheme of education, and the required philosopher may become a possibility. Till then, it is only by making our art of teaching accord with the ascertained truths of these sciences that we can reasonably hope to achieve great success; and any success we do achieve will be in exact proportion to the accord of our methods with those truths.

It must ever be borne in mind that education is a drawing out of natural powers, and that the real work of the teacher is to help natural development.

Now there is much solid land reclaimed from the swamps of ignorance in physiology, and on that land every teacher should be able firmly to plant his foot; thence he can take care that none of his methods run counter to the laws of child life; thence he can secure the co-operation of those natural laws with his own efforts. Thus he will ever have in view, when framing his plans, as when carrying them out, the principles that decide and guide his work, and will consequently feel that earnestness, certainty, and interest in his work that comes in no other way, and that, since it awakens like interest and earnestness in his children, leads more than anything else to a successful issue. He will thus compel the children to like their work. Show us a school where truants are regular and natural products, and we will show you one where the truths and laws of physiology are daily and hourly outraged.

(c) *Of their Pupils.*—The advantages of some knowledge of physiology are tolerably evenly distributed amongst teachers and taught. We have looked at it from the teacher's side; let us look at it from the child's.

Physics, chemistry, and physiology have been called the 'useful sciences,' and, from a purely utilitarian point of view, physiology forms a fitting climax to the three: it is the natural goal towards which all other sciences tend.

And here we see another reason for its late development and for its tardy appreciation. Like geology (specially palæontology) it is a descendant of the earlier sciences, and its existence has only become possible by the more or less perfect maturity of those earlier sciences.

No acquired knowledge has greater, if so great, intrinsic worth to a human being, as the undisputed facts and laws of physiology. They will be fraught with benefits to every possessor from the school to the grave. The pursuit of that knowledge is scarcely less valuable as a means of mental discipline.

7. Physiology as an educational instrument.—Physiology, when properly taught, is a most potent educational instrument, and gives, moreover, reality to knowledge by frequently bringing it into direct contact with absolute fact.

(a) *Physically.*—Physically it sharpens the senses, especially the more useful ones of sight and touch; establishes that complete unity of purpose between eye and hand, so necessary in all our more delicate and important undertakings; and in the proper gradation of the subjects of study presented to the child, engenders a thoroughly healthy physical development of the brain and entire nervous system, analogous to that of the motor organs which comes from judicious bodily exercise.

No study will better help to develope an intelligent memory, specially if the *thing* is known before the *name*, and the derivation or meaning of the word always clearly given with its first use. Physiology may lay a special claim to memory on physical grounds, since there is evidence that loss of memory is a direct result of a physical change in the condition of brain matter, producing as effective a mental blank as would loss of sight, or of any other sense that links the brain to the outer world. Memory, therefore, being based on a nervous property, is sustained by nutrition and stunted by inaction.

(b) *Intellectually.*—Intellectually it makes voluntary attention easy by utilising from the first, and to the full, that universal interest children take in living things, and so that habit of attention is acquired, which, through well-defined sensation and consequent clear perception, makes classification and generalisation or abstraction possible, and ultimately, in the higher stages, finds scope for imagination, conception, and inference or judgment. If practical work is not abused, the study of Physiology may even begin to develope those higher powers at a comparatively early stage.

(c) *Morally.*—Morally, physiology will, if taught in a right spirit and by right methods, do much to lessen that childish cruelty to animals, alas! so often conspicuous, and may permanently deepen the humane side of our natures.

Since it is constantly protesting against the acceptance of any fact without rigid enquiry and searching test, *perseverance* and *honesty* will be fostered at every step, and a consciousness of power will be awakened that will lay a good foundation for manly independence and self-helpfulness.

8. Summary of Grounds of Claim.—These, then, are the grounds on which we claim for physiology much more general and particular attention than it at present receives.

1. Life is God's most precious gift to each of us, and perfect living therefore our highest duty, and without a knowledge of physiology perfect living is impossible.
2. In education, when physiology rules our conduct, we shall secure the maximum effective result of the labour of both child and teacher.
3. Physiology has already by legislation rendered schools pleasant places, and is, although too slowly, making school-work equally attractive, and will, when its principles shall fully guide the legislation of the

Educational Department and the methods of teachers, altogether change the character of school-work for the better, as regards teacher and taught.

4. The truths of physiology possess an intrinsic value equalled by no other science, for each of its acknowledged compeers, chemistry and physics, has a more or less restricted application, whilst that of physiology is coincident with humanity.

5. As an educational instrument it compares not unfavourably with mathematics and languages in its general result, and claims special merit for producing physical as well as intellectual and moral consequences, which moreover interact upon each other.

6. Ultimately it will put home and school into perfect harmony with each other, and school years will form some of the brightest links in the golden chain of life. When physiology and psychology guide all educational methods, *home* will lead up to the duties of *school*, and school will fit for the duties of home.

CHAPTER II.

WHAT TO TEACH.

1. Limits of sciences artificial.—In teaching physiology it cannot be forgotten that the division of human knowledge into sciences is wholly artificial, and has for its sole *raison d'être* human convenience. There are no definite natural boundaries between science and science, but the one passes insensibly into, or rather overlaps, the other, so that there is a considerable portion of territory common, and only the very centre of each realm is peculiarly its own. Thus, though each science has its own laws, yet those laws have a much less restricted application than that indicated by the science itself. Whenever the necessary conditions are found in physiology, the laws of chemistry, &c., exercise full sway, and under all circumstances are factors in the results obtained.

Hence it is quite impossible to approach the study of animal physiology till a certain amount of progress has been made in those sciences from which its roots draw nourishment, and equally impossible to pursue it deeply without a knowledge of another group of sciences into which its branches extend. Thus physiology joins hands on the one side with physics, chemistry, and anatomy, and on the other with geology, physical geography, and astronomy.

2. Requirements in teacher.—It is not to be supposed that a child must study physics and chemistry before he can begin the study of physiology, but his teacher should

make himself sufficiently master of these subjects to be able to put clearly before his class the properties of the materials dealt with in each particular case, the laws to which they conform, and their chemical affinities.

It will be readily seen that a knowledge of anatomy is indispensable to both teacher and pupil.

A preliminary course of physics and chemistry is therefore desirable for the teacher, but is by no means necessary for the child.

Each lesson should contain so much anatomy as is required, and such simple experiments in chemistry and physics as are essential to an intelligent understanding of the physiological function under consideration.

Teachers, therefore, should be acquainted with the forms and properties of matter, the physical forces and their mutual convertibility, the so-called elements, specially oxygen, hydrogen, nitrogen, and carbon; such ordinary compounds as air, water, carbonic acid, common and lime salts; the difference between mechanical and chemical, stable and unstable compounds; and with the general anatomy, not only of man, but (at the least) of other *mammalia* also.

3. Only teach what is certainly known.—In animal physiology, at present, there is necessarily much that is uncertain, debatable, or purely theoretical. A teacher will show his tact in only so far noticing these portions as to direct attention to the growing points of the science, and so suggest paths to be subsequently trod.

Thus a first separation will be made between the well-established and essential portions of the science, and those doubtful or unimportant. Physiological facts and fundamental principles will be clearly distinguished from mere opinion. Lastly, a careful selection must be made even from those facts themselves. As Foster says,[1] 'To tumble out all the treasures from the physiological treasury is simply to bewilder, not to teach.'

[1] *A Text-Book of Physiology.* By M. Foster, M.A., M.D., F.R.S.

Some physiological facts are at present wholly inexplicable; these should be plainly and candidly stated. How nerve energy brings about a state of consciousness? How cerebral substance evolves intellect? How nerve stimulation becomes feeling and reason? The essential physical difference between pleasure and pain? How the mind comes to attention?

4. Three Courses in Physiology.—There should be three courses in animal physiology, each suited to the age and mental development of the pupil. Each course possesses peculiar educational merits. Each should be perfectly complete in itself, so that, should the first course fail to be followed by the second, or that by the third, the time and effort spent would not be lost, for the knowledge acquired would be serviceable, since the outline would be perfect, although details would be more or less lacking; moreover, the discipline would be valuable.

(a) FIRST COURSE.

General Remarks.—The first course should have as its primary object the exercise and consequent strengthening of the senses, especially of sight and touch. During this period, the fingers should become deft, and the eye keenly and accurately observant.

It should take the place of the ordinary 'object lesson,' and would secure all thereby gained, *plus* those advantages that come from continuous and progressive study.

It should end in the acquisition of a considerable store of facts by such close and careful observation as will, by practical use, have become a confirmed habit.

Only the more evident physiological phenomena should be dealt with, and these only in outline; such phenomena, that is, as the respiratory movements, heart-beat and pulse, change in size of pupil of eye, and ordinary voluntary muscular movements.

• COURSE :

1. *Body generally.*—This first course should deal with the body as a whole, should be analytical and almost purely anatomical. It will begin with the general build of the body, its symmetry and bilateral character.
2. *External Organs.*—Starting with the self-evident pairs of organs, it will lead up to the double structure of such median organs as the nose and mouth. A careful study of these external organs will be made, first individually, and next reverting to their bilateral character.
3. *Internal Organs.*—The position, size, shape, general character, and movements (if any) of the external organs having been observed and recorded, the internal organs should next receive attention, again, absolutely first, and afterwards as possessing a bilateral structure similar to that of the external organs.

   This should be shown first in such cases as the kidneys, lungs, brain, and next in such as spinal cord, heart, and tongue. Good models of these should be placed in the children's hands. Models will generally be preferable in this preliminary course to actual organs.
4. *Skeleton.*—Bones might, however, be seen and handled. Their shape, size, relative positions, and means of union into the complete skeleton should be known.
5. *Function.*—This course should terminate with a separate brief consideration of organs as related to their functions. By using the knowledge of the body now acquired, the general relation between organ and function may be pointed out, and so the relation of anatomy to physiology be understood. This course thus ends with a distinct

knowledge of the real province of physiology, which the children may now define for themselves.

(b) SECOND COURSE :

General Remarks.—The second course should aim not only at the acquisition of scientific facts, and at the development of the powers of observation, but also at the strengthening of the reasoning powers. Reasoning, however, must not displace observation, for experiment and practical work will still form the basis of all study. Anatomy will now become distinctly subordinate, and physiology prominent.

The *function* should be the start-point of each enquiry, and the fitness of the organ for the discharge of its function should be persistently sought. Let results be observed, causes looked for, and purposes discovered. Let the prominent questions all through this course be 'HOW IS WORK DONE?' and 'WHY IS WORK DONE?'

Thus with the organs will be associated their proper functions; the principle of 'division of labour' will be recognised in the human body; and the suitability of each organ in position, form, and substance, for the work it has to do, will be seen by a study of the broad structure of such organ.

The work of each organ should be considered as a whole, and no attempt be yet made to track it to its primary source in cell-action.

The models might here, at least occasionally, give place to actual organs from ox, sheep, pig, or rabbit. Children at this age will not shrink from handling the parts, and in so doing will learn how much the real thing is superior to any description, or picture, or even model. A model may give size, form, colour, and general appearance truthfully, and is superior to a picture, since it may be viewed from different positions, and is, indeed, equal to a series of pictures in *every* position; but it cannot give texture, and is useless for dissection. A model may satisfy the sense of sight, but cannot satisfy touch, taste, &c.

COURSE.—This course, starting with the more obvious movements of the body, will track them backwards to their source, and forwards to their ultimate results. Thus, from organs the pupil will pass on to systems, and see how organ is combined with organ, and function co-ordinated to function in the production of one common result.

1. *Circulatory System.*—The heart-beat and pulse motion already noticed will lead back to the circulatory system, then forward to its *modus operandi*, and the purposes, thereby served, of cleansing, nourishing, warming.
2. *Respiratory System.*—The respiratory phenomena as naturally suggest enquiry into their cause and purpose, whilst the *cleansing* work of the blood points to a connection between the circulatory and respiratory systems, the *nourishing* work between the circulatory and alimentary, and the *warming* work between the circulatory and nervous. The respiratory phenomena, system, and function should therefore come next.
3. *Excretory and Secretory Organs, with Alimentary System.*—The pupil, through the consideration of excretions and excretory organs, and of secretions and secretory organs, should pass to the examination of the means by which these losses are made good in the functions of alimentation and nutrition.
4. *Motor Mechanisms.*—The means by which all these and other simple and complicated movements of the body, or its parts, are produced, should next receive attention.
5. *Nervous System.*—Finally, the general nervous system, by which all is regulated, directed, and controlled, should be studied.

This course, therefore, commencing with the blood and its functions, should end with the brain

and its general function, leaving the special and detailed consideration of the senses for the next course.

(c) THIRD COURSE.—This course should aim at securing a tolerably full knowledge of the structure of the organs of the body, of the way and exact place in which they perform their respective functions, and of the principles in virtue of which they are enabled to do their work.

The first course has given accurate knowledge of the body as a whole and of its organs; the second course of the functions discharged by those organs; and this third course should aim at discovering exactly *where* and *how* each organ does its work, and at writing a *history* of organ and tissue.

General Sketch.—This course should, therefore, begin with a minute study of the various tissues, and of their characteristic properties; should then consider how these fundamental tissues are combined and arranged as mechanisms; and, finally, how they are welded into an organic whole. It will not be advisable to examine the structure and function of *all* the tissues first, then of *all* the organs, and last of *all* the systems; but rather to take first the more important and common tissues, and notice the others as the organs in which they are prominent come under notice. The organs and systems should be similarly treated.

Huxley's Elementary Text-book [1] exactly covers the ground, and is a model for precision and cautious statement, for brevity, lucidity, and point, and for its logical arrangement and developmental character.

If space would permit, no purpose would be served by specifying the exact work in this course. Briefly, therefore, let a searching enquiry be conducted first into the blood, then into the excreting and secreting

[1] *Lessons in Elementary Physiology.* By Thomas H. Huxley, LL.D., F.R.S.

tissues, and next into muscle, bone, &c.; but let the great attack be made on the 'keep' of the physiological castle, the nervous systems, sensations and the sensory organs. To this attack all preceding enquiry has been preparatory, and from a teacher's point of view, before this, all other enquiry sinks into littleness. Finally, such special phenomena as coagulation of the blood, lymph, &c., loss of pulse in blood capillaries, and formation of glycogen in the liver, may now be confidently attacked; as, also, the action of the larynx in the production of voice, and of nerves on secretory and excretory organs; and, lastly, much educational advantage will be secured by a critical examination of many so-called simple sensations and delusions of the senses.

For students in training colleges this course should clear the way to an intelligent study of the leading principles of psychology in their school management work of the second year.

CHAPTER III.

WHEN TO TEACH PHYSIOLOGY.

All through School Life.—The necessity for finding means, consistent with the necessary discipline of a school, to cultivate the observing powers of young children has long been felt, and attempts have been made in that direction with varying success. The natural inquisitiveness of children and their instinctive desire to handle the things they see has long suggested to thoughtful teachers that therein existed, ready-made, a powerful means of acquiring knowledge.

Lessons on common things, natural history lessons, and object lessons generally; ball-frames, form and colour boxes, are all attempts to turn this curiosity and tendency to confirm the evidence of one sense by another into useful channels, and have all been attended with more or less success.

In the majority of cases, however, this effort stops abruptly at the end of the infant-school course, being wholly discontinued in the boys' or girls' school. This is a mistake. It should not disappear suddenly, but, ceasing to be the prominent feature in the teaching, should gradually sink into the back-ground as the mental development of the child progresses, and should never wholly disappear even in the first class; but mere external examination should advance to internal, and then to simple test and experiment.

The study of physiology should, therefore, begin in the infant-school and continue through the entire school life.

FIRST COURSE.—The first course should begin in the infant school with the examination of the external organs, and be continued until the child has reached the fourth standard. It is a great mistake to *begin* this course when a child is preparing itself for the fourth standard; it should culminate at that standard. Yet this mistake is commonly made, and probably will continue unless physiology be made part of the ordinary school-work. A child from the beginning of its school career should be acquiring, and pleasantly too, much anatomical knowledge that it will subsequently need, and will at the same time cultivate its senses, develope for itself an intelligent memory, and from the continuity of its object lessons learn the value of unity of purpose.

The lessons should be short, and not too frequent, and would certainly be valued more if made contingent on other work being well done. They will thus come to be regarded as rewards, and their natural attractiveness will be so increased that the impressions made will be very lasting. The lessons might vary in length from thirty to forty minutes; and be given once a week only, often with manifest advantage at the end of the week. We have known an irregular Friday afternoon attendance completely cured in this simple, useful, and pleasant way. This course should terminate at the age of ten or eleven.

SECOND COURSE.—The second course should occupy the latter part of ordinary school life, from the age of ten or eleven to that of thirteen or fourteen, when to observation and memory will be added some power of reasoning.

It will be well within the reach of a child of ordinary intelligence, and, if the first course has done its duty, will be approached with eagerness.

At this age we may begin to present real objects for examination, and such skill in drawing ought to have been acquired as will enable the pupil to sketch the objects seen and the sections made; indeed, the note-books should mainly contain sketches, the only writing being the names

of the objects and their parts, and records of changes in colour, solidity, &c.

There should be two lessons per week, which might be conveniently given on Wednesday and Friday afternoons. The first would vary from 45 to 60 minutes in length; the second would rarely or never exceed 45 minutes. The two lessons should cover the same ground, the first partaking of the character of the ordinary object lesson, and the second forming a preparation for private study. The latter should consist of reading from the text-book, and comparing and testing the account therein with and by the object itself. The second lesson, if properly used, would lead to future personal study when school-days are ended.

THIRD COURSE.—The third course is suitable for pupil teachers, students in ordinary science classes and in training colleges, and if ever night schools should carry on and not repeat the work of day schools there too it may find a place.

There should be not less than two lessons or lectures per week, and each should be of, at least, one hour's duration.

This course may begin at about fifteen years of age, but not much earlier, as demands will be made for the frequent exercise of the higher mental faculties, some of which are of late development.

This course ended, the pupil will approach manhood in some degree fitted both to appreciate and discharge the responsibilities incident to that state.

CHAPTER IV.

HOW TO TEACH PHYSIOLOGY.

1. **Objects.**—To teach anything well, one must see clearly at the outset all that it is possible or desirable to secure in the study of that subject.

The following objects may be secured in the study of animal physiology, and to that end should be continuously present in the teacher's mind:—Keen and precise observing powers; sound, solid knowledge, and, therefore, clear scientific ideas; all those intellectual advantages that come of continuous and progressive study, the habits of comparing, classifying, and assigning the due relative values to facts; the power of reasoning on, and drawing inferences from, facts; that of detecting a common principle in dissimilar phenomena, and so of enunciating natural laws; and a wise discrimination in the choice of language for definition.

2. **Means.**—Certain means are available to this end, viz., LESSONS, PRACTICAL WORK, and EXAMINATIONS.

In the lesson, the brunt of the labour falls on the teacher; in the examination, on the pupil; whilst in the practice, it is about equally shared by each.

(a) THE LESSON OR LECTURE.—In the lesson the teacher is personally responsible to a very large degree for results.

In all lessons, *examination* of structure should precede that of physiological function, although it is sometimes advisable to *notice* the act and even the function first.

The lesson should consist of an inspection of the object

or act; any physical or chemical experiments needed to understand the phenomena; verbal description or lesson proper, accompanied by illustrations, and concluding with summary and definition. Questions should, of course, be scattered through the lesson at discretion, and the summary should, as far as possible, be the work of the pupils.

Spirit of Teacher.—The ultimate success of the work depends much on the spirit in which the lessons are given. That enthusiasm in a teacher begets enthusiasm in his class needs no enforcing, but that a teacher should be careful not to teach in a destructive spirit does. What the teacher is in opinion, the class is to a very large extent, but not in knowledge, experience, or judgment. The teacher's legitimate work is constructive, and to turn aside for the purpose of aiming, what is thought, a crushing blow at some other subject (and that not a scientific one) is ungenerous, inopportune, and unfair. A witticism or sarcasm may produce results wholly incommensurate, and may secure an end that could not be reached by fair and honest argument. The class or lecture room is not the place for contention; all debatable points should be studiously avoided, and opinions on side issues never obtruded.

A modest, honest, enquiring spirit, which, in the search for truth, is prepared to meet difficulties that may be insurmountable, should be that of every teacher. No teacher of physiology must be ashamed to acknowledge, 'I DON'T KNOW.'

Technical Terms.—With children, and even elder pupils, save those who have some knowledge of Latin and Greek, the technical terms present one of the greatest difficulties. There is often more alarm felt by the pupil than there need be. All this alarm and much of this difficulty will vanish, if, invariably, the teacher carefully pronounces and spells every new word, makes his pupils write it, shows its derivation (except in the first course), and then gives its precise meaning.

The teacher and examiner should remember that apparently gross errors are frequently only slips of memory as regards these technical and, as yet, somewhat unfamiliar terms.

Value of Drawing.—By teacher and pupil alike, in physiology, drawing can hardly be valued too much.

The teacher should have diagrams ready prepared, and should also freely use the black board. The prepared drawings will be all the better if made by the teacher himself. Not only will every stroke and shade be significant to him, but the pupils will feel they can do what their teacher has done.

Physiological sheets, such as Johnston's [1] or Marshall's,[2] are better, as a rule, for reference in preparatory work, or on writing reports, than for class purposes.

In sketching on the black board, it is a great advantage to have coloured chalks, and always to use the same colours to represent the same parts, as white for ordinary outlines, red for arteries, blue for veins, yellow for nerves, &c.

The pupil should study the illustrations in his text-book, since they must often take the place of model or object; he should copy the diagrams employed by the teacher in his lesson; and no report should ever be accepted that is not illustrated by sketches.

(b) PRACTICAL WORK.—Besides what is done by the teacher in his lesson, a special time should be appointed for practical work by the pupil, under supervision.

Conduct of Experiments.—The teacher should remember that much harm may be done to morals by an inconsiderate mode of conducting experiments. Animals, even when dead, may be so handled as to produce either hardness and

[1] *Johnston's Illustrations of Natural Philosophy.* Sheet No. 6, Physiology.

[2] Physiological Diagrams, produced under the direction of John Marshall, F.R.S., F.R.C.S., Professor of Surgery, University College, London, for the Department of Science and Art.

cruelty, or to raise such feelings of repugnance or disgust, that what would be a powerful friend is transformed into a foe. Consideration and feeling should be conspicuous in the conductor of any physiological experiment that deals with sometime living tissue.

In teaching physiology, there is not the slightest need for vivisection, which would, indeed, be wholly out of place, since it would answer no purpose that might not be served by other means. In original research it is undoubtedly a necessity, but class-work and original research are widely different.

Necessity of Practical Work.—The great importance of practical work, to a large extent through the persistent efforts of Huxley and Foster, is now pretty generally felt.

The former says :[1]—

'It will be well for those who attempt to study elementary physiology, to bear in mind the important truth, that the knowledge of science which is attainable by mere reading, though infinitely better than ignorance, is knowledge of a very different kind from that which arises from direct contact with fact; and that the worth of the pursuit of science as an intellectual discipline is almost lost by those who seek it only in books.'

The latter says :[2]

I have supposed the reader to be willing to handle and examine such things as a dead rabbit and a sheep's heart, and written accordingly. I have done this purposely, from an increasing conviction that actual observation of structures is as necessary

[1] *Lessons in Elementary Physiology.* By Thomas H. Huxley. Preface to 2nd Edition.

[2] *Physiology.* By M. Foster, M.A., &c. Preface.

for the sound learning of even elementary physiology, as are actual experiments for chemistry.

Caution in Use of Practical Work.—Care must, however, be taken not to over-emphasize the value of experimental work.

Practical work may be almost wholly mechanical, and then it is almost useless.

As book-work without practical work is bad, so is practical work without book-work, or its equivalent—teaching. Either, alone or disproportionate, is imperfect and, therefore, comparatively bad. A judicious adjustment, in time and quantity, of the one to the other is the work of the teacher.

The pupil must not become a mere collector of facts or specimens. Collection without classification and generalisation is of little use. Work of the mind must succeed and complete that of the senses. As no one can build without materials, so one may have materials and yet be unable to build.

Foster says :—[1]

'Practical work is only of value in so far as it *suggests* or *corrects* ideas. The student who has mounted an exquisitely thin and beautifully stained section, is only just so much the worse for his pains (as far as physiology is concerned) if he does not *understand* what the section means.' (The italics are ours.)

The eye is an instrument of the mind, and what the eye sees, therefore, depends on the state of the mind. The mind sees, not the eye; hence, as a general rule, what the eye sees is what is looked for. Book-work, therefore, has its legitimate and necessary work in so preparing the mind that it may tell the eye what to seek.

Again, there is no need to see or do everything; indeed,

[1] *A Course of Elementary Practical Physiology.* By M. Foster, M.D., &c., assisted by J. N. Langley, B.A.

as a matter of intellectual discipline, it is unadvisable; in much research it is impossible so to do, and, therefore, education should prepare a child to deal with such cases. Conception and imagination must have exercise if their growth is to be healthy and vigorous. The better the educational work has been done, the less will the pupil feel the necessity of actually seeing or doing everything.

Record Experiments.—Dissections and other practical work should be first done by the teacher, and then by the pupils, either individually or in groups, according to circumstances.

Although the pupil should work under direct supervision, he should be allowed to do so as independently as possible.

Teachers will do well to insist on having everything sketched and described on the spot, while the object is at hand to be appealed to in any case of doubt or indecision. Remember that any record loses value as the interval widens between the making of the observation and its record; and that, therefore, generally, those accounts will be truest and fullest that are made at the actual time of observation.

Let those students be especially commended who observe and record the most minute details.

(*c*) EXAMINATIONS.—Try the work constantly. Set test questions on preparatory work; use oral questioning freely during the lesson; have reports made of the lesson and of the practical work; and hold periodical examinations.

Test Questioning.—From five to ten minutes may be set aside at the beginning of every lecture, during which two questions, to be taken alternately round the class, are answered on paper. These can be glanced through by the teacher in a few minutes, whilst the pupils are checking, from their text-books, the answers they have made. Any general correction may be at once made. A careful examination will be made afterwards, and any gross errors mentioned generally, but the names of those whose answers are best may be announced before giving the test questions at the next lecture.

Oral Questioning.—In oral questioning, during and at the close of the lesson, let the pupils, as far as they can, correct erroneous replies.

Reports.—The reports of lessons and of practical work should be sent in for examination within two days; corrected individually by marking imperfections, omissions, and errors; then returned to be amended, where possible, by the pupil himself. These amendments will be scrutinised by the teacher when the book next returns.

No class notice should be taken of any fault that is not tolerably general (unless a rebuke is intended), but the value of each report should be indicated by some sign or letter.

Examinations.—Periodical examinations should be held, and lists published showing the absolute and relative values of the papers.

These should occur every month or six weeks, and opportunity be previously given for revision.

Each examination should cover the whole field of the pupil's work in the subject, special prominence being given to that which is subsequent to the last preceding examination.

Where time will permit, the individual errors and weaknesses should be noticed when the papers are returned.

Absolute values should be assigned to each answer in the paper set, and the aggregate of such values should fix position in the list. To cancel a paper for one or more gross errors in any answer would be to ignore much good work, and to punish neglect of any particular portion of the whole range of work with undue severity.

3. Methods.—General Method.—The method of giving each lesson or lecture must necessarily vary somewhat with the course; but, generally, the organs concerned must first be well known, then the principles involved in the discharge of the function under consideration, and, finally, the application of those principles to the special organs engaged in this work.

It will be understood that no hard and fast line is intended to be drawn here, but that room is left for the exercise of tact and judgment on the teacher's part.

METHOD IN FIRST COURSE.—1. *No Text-Book.*—No text-book whatever should be used by the pupils in this course, but they should gather all their knowledge from freely used diagrams and from models, the teacher rather directing their own efforts to acquire knowledge than imparting it to them, and only helping them when necessary to keep from straying or prevent misunderstanding.

2. *Form-Box.*—The ordinary 'form-box' should be supplemented by others containing models of animals and of the chief internal organs. There should be, what we may call, an inorganic and an organic form-box in every infant school; the latter containing models of typical and familiar animals. For use in the lower classes of every boys' and girls' school should be a second organic form-box, containing models of all the more important internal organs of the human body.

3. *Note-Book.*—On entering the fourth standard each child should be supplied with a note-book, in which brief accounts will be written and sketches made of whatever is studied.

4. *Order of Lesson.*—Commence the lesson by showing the model, picture, or diagram, and obtain from the class whatever can be got by a general survey, then pass it round for closer inspection. Next take up, one by one, the observations made, and arrange them according to their relative importance, doing this by judicious questioning. Sometimes it will be necessary to tell the class what especially to look for; in that case ask for evidence of its presence.

5. *Tests.*—After the first few lessons various models may be given or pictures shown as tests, for each child to identify and describe orally before the class.

6. *Notes of Lesson.*—The following 'notes of a lesson' will probably show more clearly the method intended to be pursued in this preliminary course.

NOTES OF A LESSON ON THE HEART.

Length of lesson, forty minutes; *age of children*, ten years.

MATTER.	METHOD.
I. INTRODUCTION of subject (*a*).	(*a*) Introduce by questioning, to awake interest. Each child's hand just below left breast—pause—ask result. You have kept rabbits, white mice, guinea-pigs, or have had pet dog, kitten or bird in your hand. Did you ever come home and find one dead? How did you know it was dead? Looked at, watched, chirped or called, touched, picked it up and placed hand on breast—not the slightest movement. Something then had stopped. What? Its heart: *Deduction*: 'OUR HEARTS BEAT AS LONG AS WE LIVE.'
II. THE HEART. Its sheath, size, shape and colour (*b*); base, apex; right and left auricles(*d*)—great vessels and positions (*c*), *Pulmonary* (*d*) *Artery* near rim of base, AORTA (*d*) central, two CAVÆ (*d*) into right, and PULMONARY veins into left Auricles.	(*b*) Model of heart—carry round class—get size, shape, colour, sheath and vessels observed—show them base, apex and auricles in connexion with *shape*, and lines of fat in connexion with *colour*—draw attention to attachment of sheath to bases of great vessels. (*c*) Make diagram on board to show position of great vessels. (*d*) Spelling and meanings of pericardium, auricle, pulmonary, aorta, and cava. Ventricle, bicuspid, tricuspid, and semilunar.
III. POSITION *relative* (*e*) to lungs; between — *absolute* (*f*), base central, apex downwards forwards and to left.	(*e*) Picture of rabbit, showing contents of chest—get relation to lungs and position of base and apex as regards right and left. (*f*) Diagram of vertical median section of human chest—observe position as regards top and bottom, back and front of chest. *Deduction*: 'APEX DIRECTLY MAKES BEAT FELT.' Let children pick out great vessels in each diagram, and observe colour of blood in vessels.
IV. INTERIOR — hollow, varying thickness of walls (*g*)—4 chambers, 2 auricles, 2 ventricles(*d*)—openings (*h*) *into* heart no valves; *within*, from auricles to ventricles, BICUSPID(*d*) and TRICUSPID (*i*); *from* heart, semilunar (*d*) valves at Aorta and Pulmonary Artery (*i*).	(*g*) Model should so open vertically as to show chambers and relative thickness of walls—show relation of outward lines of fat to chambers. (*h*) Drawings of horizontal sections to show openings and valves. (*i*) Diagrams on black board of a Bicuspid or Tricuspid *flap*, and of a Semilunar *pouch*.
V. BILATERAL STRUCTURE OF HEART (*l*).	(*l*) Analogy to nose. Previous lessons will render it unnecessary to dwell upon this portion of the lesson.

METHOD IN SECOND COURSE.—1. *Text-Book after Lesson.*—Let the class use a text-book now—and no better book could be desired than Foster's 'Physiology'[1]—but always let the lesson precede its use, or memory will do much that other mental powers should.

2. *Lessons in Pairs.*—In this course the lessons should

[1] *Science Primers. Physiology.* By Dr. M. Foster.

run in pairs, one pair being given per week with an interval of one or two days between. In the first work without, in the second with, text-book. The first lesson should be given as in the first course, except that function should be prominent, and evidence be sought of structural fitness of organ for the work it has to do.

3. *More Details.*—Of course there will be fuller details.

4. *Draw in Note-Book.*—The pupil will now find abundant use for note-book ; verbal description and explanation should be encouraged, and sketching made imperative.

5. *Use Natural Objects.*—Natural objects, *carefully prepared beforehand*, may now be placed before the class, and, if properly done, without fear of producing either callous results, or of shocking natural delicacy, and with the certainty of developing observation, since the sense of sight will thereby receive the co-operative aid of the other senses.

6. *Experiments.*—Simple physical, chemical, and mechanical experiments will be performed in nearly every lesson by the teacher, such as the formation of the common gases, the passage of such gases and of solids in solution through membrane, the effects of heat and cold on water, the result of stretching and relaxing elastic bodies, lever action, &c.

7. *Class Use of Text-Book.*—Between the lessons constituting a pair let the child study the subject from his text-book, and in the second lesson let the class read aloud from the book, the teacher commenting and questioning thereon, and verifying the statements. He should also encourage the pupils to ask questions, the class supplying answers when possible. In the latter part of this course the reading in the class might advantageously be dispensed with, and the subject at once discussed.

8. *Rehearsal.*—After this the organ under consideration should be again examined, and the experiments performed, one or more pupils being selected to do this work as an honourable distinction. The second lesson should end with alternate test questions to be answered on paper.

NOTES OF A LESSON ON BREATHING AND THE LUNGS.

Length of lesson, one hour; *age of children*, thirteen years.

MATTER.

I. The Act of Breathing. Air and lungs concerned (*a*); changes in each, in gases, temperature and moisture *of air* (*b*); in size *of lungs* (*c*); oxygen gives place to carbonic acid (*d*); temperature approximates 100° F. and moisture, saturation—so lungs get rid of carbonic acid, water, and heat, and gain oxygen —expansion of lungs made obvious by rising of chest (*e*).

II. Lungs and Thorax. Conical, air-tight chamber; lungs, a cone, but smaller, out of chest; in life vary as chest—lungs always fill chest (*f*); variations result of muscular action of diaphragm (*i*) and intercostal (*i*) muscles of ribs (*g*); *air-vessels*, trachea (*i*), bronchi (*i*), bronchial tubes and sacs let air enter and fill lungs—*blood-vessels*, Pulmonary Artery, air sac capillaries, and Pulmonary veins keep current of blood constant though lungs (*h*).

III. Fitness of Organ for its Work. In *position* (*f*) near heart. In *structure* (*h*); hollow, honeycombed, so large surface for exposure of blood—lining, a thin membrane readily permitting diffusion of gases, &c., permanently open pipes communicating with outer air. In highly elastic *property* of tissue (*c*), and so, ready change of capacity.

IV. Function (*k*). By above interchange, to *purify* blood of certain wastes, and to *supply* oxygen and so change venous into arterial blood.

METHOD.

(*a*) Watch one asleep. How do you know it is *sleep* and not *death?*

(*b*) Take long inspiration—observe change in chest—breathe out part of air on cold slate to show moisture and temperature; and remainder through lime-water to show carbonic acid.

(*c*) Blow into rabbit's lung or lobe of sheep's.

(*d*) Make oxygen *beforehand*—in class show properties, obtain carbonic acid by burning charcoal in it—show properties of carbonic. *Illustrations* of diffusion of gases—visible action in ginger-beer, lemonade, or cider—change in taste of stale beer or wine even if dry or wet bladder cover it.

N.B. Blood is 'a gas-charged fluid covered by wet membrane.'

(*e*) Mercury in tube to show pressure of atmosphere.

N.B. Caution.—Lungs don't *lift* chest-wall; muscles do, and air pressure fills lungs.

(*f*) Two drawings of rabbit's thorax, one with uninjured, other with pricked walls—cause of difference in appearance of lungs.

(*g*) Experiment with rabbit's lungs in bottle with elastic bottom.

(*h*) Diagram of vertical section through trachea and lungs—3 sets of pipes, conveying air, bright and dark blood—their relative positions.

(*i*) Spelling, derivations, and meanings of diaphragm, intercostal, trachea, and bronchus.

(*k*) Write on black board.

METHOD IN THIRD COURSE.—1. *Text-Book before Lesson.*—Huxley's 'Elementary Lessons in Physiology,'[1] or some other book of similar character, will suit this course. A certain portion should be set for the pupils to study before the lecture. The thoroughness of this preparatory work having been tested, the lecture itself will proceed much as in the second course, viz.:—

2. *Order of Lesson* :—

1. See objects, experiments, &c.
2. Hear lecture.
3. See objects, &c., again.

3. *Practical Work.*—Then, as soon as convenient, the pupils should have practical work bearing on the subject of the lecture.

4. *Reports and Report-Books.*—Reports of the lecture, with diagrams, and of the practical work, with sketches, should then be sent to the teacher for examination, and as soon as possible returned, marked for correction by the pupil himself. Where great errors are made the teacher should correct *in brief*, leaving the pupil to do it fully.

Rough notes may be taken both of lecture and of practical work, and also of the diagrams employed in the lecture, but the drawings made during the practical work should be final.

The lecture and practical work reports should be in separate books.

The reports should be completed within two days, and the corrections within other two.

5. *Microscope, &c.*—Into our service must now be pressed all the help that science and art can yield. The microscope must be always at hand. Generalisation, inference, and all the higher mental processes should find ample scope.

6. *Preliminary and Explanatory Work.*—In the lectures,

[1] *Lessons in Elementary Physiology.* By T. H. Huxley.

as food-stuffs are considered before alimentation, and levers before motion, so there are certain matters that demand consideration before other functions are attacked; for example—

(*a*) BEFORE RESPIRATION.

a. The diffusion of free gases.
b. Free gas diffuses from a liquid.
c. Free gas diffuses through either a dry or wet porous membrane.
d. Water dissolves carbonic acid gas more readily than it does oxygen.
e. Carbonate of lime is formed by the passage of carbonic acid gas through lime-water.
f. The gases of the atmosphere are *mechanically* mixed.
g. Hæmoglobin of red blood corpuscles has some chemical affinity for oxygen.

(*b*) BEFORE HEARING.

a. Nature of sound waves.
b. Relation of sound to a stretched membrane.
c. Vibration of particles individually and *en masse.*
d. Sympathy of a tuning-fork, &c., to a particular note.

(*c*) BEFORE SEEING.

a. Nature of light.
b. Influence on light of media varying in density.
c. Influence of convex, concave, and biconvex lenses on light.
d. Relation between distance of focus and that of object.
e. Relation between nearness of focus and degree of convexity.
f. Inversion and reversal of images.

7. *Modus Operandi.*—After the body of the lecture has been given, the means by which the principles concerned are so employed by the organs as to result in the proper discharge of the function, should be briefly summarised.

Take as example, HEARING, and show the steps by which the physical agent, *Air waves*, results in the mental phenomenon, *Sound*. Thus :—

a. AIR WAVES passing up meatus impinge on tympanic membrane.

b. Vibration of tympanic membrane.

c. Oscillation of auditory ossicles, and also production of waves in air of tympanum.

d. Vibration of membranes of fenestræ ovalis and rotunda.

e. Vibration of perilymph and contents, viz., membranous labyrinth and scala media.

f. Vibration of endolymph and contents, viz., hairs, otoconia and fibres of Corti.

g. Stimulation of fibres of auditory nerve.

h. Transmission of impulse to brain.

i. Consciousness of SOUND in the mind.

8. *Practical Work.*—Practical work should follow as close on the lecture as possible. For instance, after a lecture on the eye, that organ from an ox or other animal should be critically examined in some such way as the following.

DISSECTION OF EYE OF OX OR SHEEP.

A dish with water, a paraffin tablet, scalpel, pair of scissors, forceps, needle and pins will be needed.

Pick off the fat and reveal the muscles and optic nerve; observe point of entrance of optic nerve to ball; remove the muscles and reveal the sclerotic; observe line of junction with cornea; pin the eye on the tablet, with cornea upwards; make incision on cornea, aqueous humour spirts out; with scissors, cut away cornea and examine it; observe, it becomes opaque when stretched; note iris resting on the lens; gently squeeze the eye-ball, and the lens (perhaps in its capsule) rises through the iris; remove lens-capsule and examine; insert needle in equator of crystalline lens; note

evidence of its high density, and also the different degrees of convexity before and behind; preserve it for sections; remove iris and examine; observe blood-vessels, &c., through vitreous humour; remove vitreous humour and with it the retina by parting the ciliary processes and cutting through the blind spot; examine retina and preserve for sections; with forceps raise choroid coat; examine its pigment cells; and, lastly, the strong sclerotic capsule. The iris, ciliary muscles, retina, lens, and pigment cells should be examined under the microscope.

4. **Apparatus.**—Both in conducting lessons and practical work certain special apparatus is necessary for teacher and pupil.

FOR CLASS PURPOSES.—A box of coloured chalks for black-board use; a set of physiological charts; numerous small separate diagrams; models, especially of ear, eye, and skull with brain; a good microscope, with inch and quarter-inch lenses, and materials for mounting, viz., glass slides and covering glasses, wire clips and Canada balsam, soluble Prussian blue and carmine; a small spirit lamp; a syringe and pipettes; several different-sized test tubes; bottles of distilled water, salt solution, limewater, glycerine, and methylated spirit; acetic, nitric, and chromic acids, and a few other chemicals, as bicarbonate of soda, sulphate of soda, ferrocyanide of potassium, and nitrates of silver and barium.

FOR INDIVIDUAL USE.—A magnifying glass, a scalpel, a pair of scissors; several sizes of needles and pins (the former square in section, the latter with large black heads), a box of crayons, some stout cardboard, cork, and a paraffin tablet.

Spottiswoode & Co., Printers, New-street Square, London.

HOW TO TEACH BOTANY.

CHAPTER I.

INTRODUCTION.

Botany, or the science which treats of plants, is a very wide subject indeed; but we have to consider its study in reference only to the requirements of the New Code, which must, therefore, be our guide. Our remarks consequently will be limited to those elementary subjects which are laid down in the three stages of the Educational Code as given in the Fourth Schedule (p. 30, 1879).

The teacher should bear in mind the extreme importance of seeking to instil into the young mind habits of accuracy both in observation and description. Botany is an exact science, and no slipshod or loose-way of teaching it will do at all. He will be encouraged in his work by remembering what great benefit he may be able to confer upon the young boys and girls under his charge by a patient and judicious method of instruction. How frequently have persons, in whom a love of plants or animals has been implanted, been kept in the right path—and I feel sure that this should be the ultimate end of all teaching—by the study of those wonderful living organisms with which we are surrounded. What health may be earned by outdoor wanderings over field or hill or moor, or by the side of some plant-environed pool or lake! Consider, too, how by judicious teaching you will be training the future man or woman to

habits of exact observation; how, if you can only succeed in erecting a solid framework, the building may in time attain to a great altitude and noble proportions. But you must use much patience and diligence. Of Botany especially may it be said that there is no royal road to its study. The old Greek proverb, 'Hasten slowly,' so dear to the Roman Emperor Augustus Cæsar, is well worth remembering, as is also the somewhat similar aphorism, 'That is done fast enough if it is done well enough.' And now let us see first of all—

1. **What is required in a Teacher of Botany.**—First, he should have a love for the subject taught; secondly, an accurate knowledge of its fundamental points; and, thirdly, patience and an attractive method of teaching. If a teacher is possessed of these qualifications success is sure to follow, though of course there will be much difference in this respect according to the ability and industry of the scholars.

2. **Necessary or desirable aids to the study of Botany.**—Perhaps there is no science which requires less machinery than the study of elementary botany. You must have a good text-book,[1] a sharp knife, a pair of finely-pointed forceps, a magnifying lens, and a few long and strong needles firmly fixed with their heads into wooden handles, which you can improvise for yourself any time. These are

[1] I strongly recommend every teacher to procure Professor Oliver's *Lessons in Elementary Botany* (Macmillan and Co.). It is, I think, scarcely possible to speak in terms of too high praise of this admirable little handbook: I have not hesitated to make free use of it, although the plants themselves have been always before me. It can be carried in the pocket as you ramble in the fields and lanes. As a more advanced work on structural and physiological botany special mention may be made of Mr. Bennett's translation of *Otto W. Thomé's Text-book* (Longmans and Co.). Mr. Bentham's *Handbook of the British Flora* will be found excellent in all respects. Those who are interested in plant-lore will find much entertaining and instructive matter in Dr. Prior's work on the *Popular Names of British Plants* (Williams and Norgate).

necessary (the lens and pocket-knife should be carried about with you both at home and out of doors); a vasculum or tin vessel for carrying specimens will also be found useful. This apparatus, simple and inexpensive, will be sufficient for the study of the *Morphology* of plants, or that part which treats of their external forms. But for the study of the minute organs of which plants are composed—of *Structural Botany*, as it is generally called—a compound microscope from about 40 to 100 diameters is absolutely essential.

Other aids will be found most useful and desirable, though not absolutely necessary. I may mention especially the late Professor Henslow's admirable sheet diagrams, published for the Committee of Council on Education; also I should strongly recommend the use of the 'blank schedules' introduced by the same botanist; the 'Floral Dissections,' by the Rev. G. Henslow, for the use of schools and students in botany, recently published, will be found serviceable; but above all things—

3. **The actual plants must be principally studied.**—Attempts to teach botany without constant examination of the plants themselves are comparatively useless; the best manuals and the most carefully drawn and accurately designed diagrams are in themselves alone powerless to produce in the mind any real knowledge of the subject. The plant itself must instruct both yourself and your pupils. Of course, the apparatus I have mentioned is most useful and necessary; but you must practise floral dissection for yourself, and teach your pupils to do the same from the actual specimens.

4. **Botanical terms.**—To what extent is it desirable to make use of them? Some there are who think that a knowledge of technical terms is only in a very small degree essential, and that plain English words and phrases would be better. But when we consider the fact, that it has long

been, now is, and probably will long continue to be, the custom to explain the structures of plants, and to describe their several parts, in technical language, it is clear that unless the pupil be taught the meaning of these botanical expressions, he may be utterly unable to understand what he may read in books on botany. A person cannot learn a new language, written in strange characters, unless he has made himself acquainted with these characters. Botany has its alphabet, and you must to a considerable extent know that alphabet yourself, and to some extent teach it to your pupils. The late learned and most estimable Professor Henslow felt the necessity of this. I have before me as I write his 'Practical Lessons on Botany,' published in 1858, on the first page of which he writes :—'Experience has satisfied me that "structural botany" may be more conveniently and extensively employed than any other branch of natural science for strengthening the "observant faculties" of children in all classes of society. But, in order to secure a beneficial result, we must not avoid the use of certain technical expressions, however pedantically unnecessary they may be to persons unacquainted with their importance and unaccustomed to their use. Scientifically accurate ideas must always be conveyed either by entirely new words or by peculiar technical meanings assigned to old words. Botanists employ both methods. Some of the most important technical terms have not been judiciously selected. Some are too long, others harsh and ungrammatical. But the few terms to which these objections apply cannot be satisfactorily dispensed with. They are thoroughly established, and are, in fact, much more readily learnt than might be imagined.' I do not say that you are to try to *cram* whole pages of the technical terms of descriptive botany into the minds of your pupils in a given space of time; but gradually these terms may be learnt without much mental effort on the part of the learner, and with the application of no more than ordinary diligence and tact on that of the teacher.

But you must remember that certain very definite and decided meaning is attached, generally speaking, to these technical terms; therefore they must be clearly understood; you must be sure that you yourself know fully the meaning of the terms employed, and then you will have not much difficulty in making your scholars understand them. Remember the old Latin expression, 'Nil sine labore,' and be the more diligent; and do not forget the other saying, 'Labor omnia vincit,' and be encouraged.

5. **How and where to begin.**—Begin at home, and confine your lessons, at first, to such plants that grow in your neighbourhood, and with which children are all more or less familiar. Perhaps the whole school can sing the pretty little song,

> Buttercups and daisies,
> O the pretty flowers.

Well, then, you may begin with the buttercups. Take care to procure some good specimens. There are about a dozen species of the genus *Ranunculus*, of which the meadow buttercup, *R. acris*, is one of the commonest and most easily procured. Following the instructions in the Code, you will proceed to notice the characters of the root, stem, leaves, and parts of the flower.

6. **The root.**—Take care that you have got the plant well up by the root, so as not to break off the numerous fibres. It will be as well at first to confine your instructions, as a rule, to the *parts* of plants, before you give lessons on their internal structure, and the functions of their different parts. You will draw attention to the difference in appearance or mode of growth that exists between the stem and the root; there is difference in colour, the root being nearly white, the stem more or less green. You need not at this stage say anything about *chlorophyll*, the green colouring

matter of plants; that will come in by-and-by. The root differs from the stem in direction of growth: its direction is downward, that of the stem is upwards; the stem has buds and leaves, the root has none; the tips of the root-fibres possess a cellular sheath or covering, peculiar to them; but some careful manipulation is necessary in order to see this clearly. Now I wish you to observe these general characteristics of a root, because there are some underground or creeping stems which popularly are taken for roots; and I dare say that you could create much astonishment were you to ask a number of persons in a room seriously the question what portion of the plant is the tuberous production known as the potato. Nine persons out of ten would, I think, smile at you and say: 'Why, of course it is the root.' It is, however, not the root; for the potato, you know, possesses a number of depressions on its surface, popularly termed 'eyes,' and these are irregularly developed buds, and are able to produce leaves and whole plants. *A true root, botanically speaking, is destitute of buds and leaves*; a potato, therefore, is not a root, but a swollen underground stem containing about fifteen per cent. of starch.

7. **The stem and foliage leaves.**—Now draw attention to the stem, which in the specimen rises nearly straight from the ground; in the creeping buttercup (*R. repens*) there are two kinds of stem, one ascending and bearing flowers, the other running from among the root-leaves, giving off roots at its joints forming fresh plants. The flower-producing stem has several leaves on different sides of it, which like the stem itself are green; those near the root have long stalks, the upper leaves have none. In structure the stem, though somewhat tough, is not at all woody, on which account it is called *herbaceous* (from the Latin *herba*, 'grass'), a botanical term, with a definite meaning, applied to all plants which have soft (i.e. succulent) stems, and which die annually, as distinguished from trees and

shrubs which have woody stems. Observe the parts whence the branches spring; they proceed from the points where the green leaves are given off from the stem; each branch occupies the angle which the leaf makes with the stem; that angle is called the *axil* of the leaf, from the Latin word *axilla*, an 'arm-pit.' Let the meaning of this term be imprinted on the memory of your pupils. There may be several branches on one plant, and all end in buds or flowers. These buds or flowers are really a kind of leaf, but at present you may confine your lesson to the green or foliage leaves as they are called. Now take the opportunity of teaching your pupils the meaning of another technical term. Your specimen of buttercup bears leaves with long stalks which spring from near the root, that thickened portion of the stem more or less covered by the soil; from their proximity to the root they are called *radical* leaves; that part of the stem whence they spring is called the *stock*.[1] Now draw attention to those points on the stem from which a leaf is given off: each point is called a *node*, from the Latin *nodus*, a 'knot' or 'protuberance;' the intervening space between two nodes is called an *internode*. Now observe the radical or stock leaves; notice the excessively long stalk bearing at its extremity a deeply divided part; the radical leaf, you see, consists of two portions, and it is necessary to distinguish these two parts by two distinct names. The long portion is called a *petiole*, from the French *pétiole* (*that* from the Latin *pes, pedis*, 'a foot'); the segmented terminal portion is called a *blade*; the *segments* of the blade vary in number from three to five, or even seven; and they again are cut into other parts or lobes. Those leaves which spring from the upper portion of the stem are without stalks (*petioles*), and as they sit, as it were, upon the stem they are

[1] Children should be made to spell and write on the black board, or on their slates, each new term as it occurs; and the teacher should be constantly testing their memories by the same question repeatedly asked. What is apparently lost in time is, I am sure, actual gain.

termed *sessile*, from the Latin *sedeo*, 'I sit.' All leaves which clearly spring from the stem are called *cauline*, from *caulis*, 'a stem.' A stem may be either *hairy*, as is the case with the meadow buttercup before us, or it may be *glabrous* (Latin *glaber*), 'smooth.'

8. **Flowers.**—You will next direct the attention of your class to the flowers, which in the buttercup are yellow and shining. You may, I think with profit, sometimes refer to the meanings of the English names of plants; but I would recommend you to do so sparingly, so as not to interfere with the regular lessons in structural botany. From the name and colour, the flower before us would seem to have reference to 'butter' and 'cup,' i.e., the little cup of the colour of butter. There seems, however, to be no doubt that it comes from the French *bouton d'or*, 'golden button;' the name bachelor's button is sometimes given to a double variety of this flower. The 'cup' is the old English name of *cop*, 'head' (German *kopf*), so that the original meaning was 'button head.' Now you observe that the flowers are set upon stalks, and note that a distinct term is used to express the flower stalk: as the stalk of the leaf is definitely known by the name of *petiole*, so the flower-stalk is known by that of *peduncle* (*pes*, 'a foot'). Be sure to take care that your pupils bring you good specimens of plants: your buttercup should possess not only full-blown blossoms but also unopened buds, because then you will be sure that the flower has lost none of its parts. In examining the flower so as to discover its several parts, there is need of much care and attention. You will call attention to the five outer leaves, separate from each other, which in the meadow buttercup are greenish-yellow when freshly gathered, and hairy; they are not cut into divisions, and are therefore to be described as *entire*; these five leaves fall off early, hence they are described as *deciduous* (Latin *decidere*, 'to fall off'). Let each child pick these five outer leaves, one

by one, from the outer parts of the flower, and it will be found that they are free or separate from each other. These leaves are placed in a *whorl*, a term which expresses an arrangement of a number of leaves or other organs around (*whorl* or *whirl*, Lat. *verticillum*, from *vertere*, 'to turn') a stem in the same plane with each other. Singly they are termed *sepals*, a term apparently made up of Lat. *separ*, 'separate,' and *ala*, a 'wing;' while together they form the *calyx* or 'cup' of the flower. The sepals being free from each other, as well as from other parts of the flower, the calyx is said to be *polysepalous*, i.e., literally, 'having *many* sepals,' but it is used to denote that these parts are *free* rather than numerous; as a rule, there are not more than five sepals in a flower.

After having picked off the sepals of the calyx, there will be seen five separate bright yellow leaves, also arranged in a *whorl*, and considerably larger than those of the calyx; note their point of insertion, which is opposite, not to the sepals themselves, but to the intervals between the sepals. Singly they are termed *petals* (Gr. *petalon*, 'a leaf or metal plate'), or *corolla-leaves* (Lat. *corolla*, 'a little crown'). Let the pupils pluck these petals off, and it will be seen that, like the sepals, they are free; the corolla, therefore, is *polypetalous*; the petals are also of the same size and form, so that the corolla is *regular*. As the petals do not remain attached to the other parts of the flower, they, too, like the sepals, are *deciduous*. And now we have not much left of our buttercup flower; at the same time we have the most important part remaining.

9. **Stamens.**—The third inner series consists of a great number of little organs which, unlike the sepals and petals, do not remind one of leaves. It will be desirable with a pair of forceps to pull them off and place them in some of the pupils' hands; they can be seen by the naked eye, but better under a lens. You should explain the several parts

of these organs, called *stamens*, on the black board, showing the stalk, or *filament*, which supports the little oblong head called the *anther*; as these stamens, or staminal leaves, are free and numerous, they are said to be *polyandrous*. Each *anther* or oblong head of the *stamen* shows a groove both on the outer and inner side, the outer one being more distinctly seen than the inner one. You will explain how these little organs split open near the outer edge and throw out little particles of yellow dust, called *pollen*, from the Latin word *pollen* or *pollis*, 'fine flour.' Now let your pupils pick off these stamens, leaving a few here and there; with a lens it can be seen how they were arranged in a crowded mass around the green ball which is now the only part left; the little scars which remain after the stamens are picked away are visible under a lens, and show that they were inserted upon what is termed the *floral receptacle*, i.e., the top of the peduncle from which the whole collection of flower leaves springs. When stamens or petals are thus inserted, they are said to be *hypogynous*, i.e. under the female part of the flower.

We have now only to attend to the little green ball which remains; and this consists of a number of closely packed, flattened, and somewhat ovate bodies of a green colour when ripe; at the tip of each of these bodies there is a small curved point or hook, which is the remains of the *pistil* of the plant; each of these organs is a kind of hollowed leaf, and contains a single very minute pale coloured body attached to the base of the cavity; the containing body is called a *carpel*, or *carpellary leaf*, from a Greek word meaning 'fruit;' the contained body is called an *ovule*. The examination of the carpellary portion of the buttercup is attended with some little difficulty, and requires some skill and patience, at least more than young children possess. You, the teacher, however, will find that verification of what has been stated is quite within your reach; and when from personal examination of these parts you have impressed

your own mind with these facts, you can readily explain them by drawings on the black-board to your class.

In order to explain more easily the form of the *pistil* of a plant, you should select some other flower than a buttercup, which does not show this organ very clearly; for instance, the *stigma* of the buttercup has scarcely a perceptible stalk, or *style*.

The carpels of the buttercup, though forming a globular compact head for a time, are free from each other; each carpel contains one *ovule*, which is the rudiment of a future seed. The parts of the pistil being free from the calyx, the pistil is said to be *superior*; and as the carpels or ovaries are all free and distinct, the *pistil* is said to be *apocarpous*. The stamens are the male parts, and the pistils the female parts of the plant; their functions will be noticed in Chapter II.

I have dwelt at some length in describing a buttercup, and I am sure that, beginning with some such common and familiar plant, and insisting that every part of it should be well studied, and the technical terms clearly understood, a foundation, small, it is true, but useful, will have been laid on which the pupil may safely build.

10. **Common plants should be gathered and compared with the buttercup.**—Almost any kinds will do. Let us take the pea, apple, white or red dead nettle, the stinging nettle, and the cuckoo pint. Now the modification of the structure of flowers is in a great measure brought about by three conditions, expressed by the botanical terms of *cohesion*, *adhesion*, and *suppression*. In ordinary language the two first terms are, or may be, used as synonyms; it is not so in botany. By *cohesion* you must understand the union of like parts of a flower, as that of sepal with sepal, petal with petal, &c.; by *adhesion* you must know that the union is one of unlike parts of the flower, as that of ovary to calyx, stamens to corolla, or pistil, &c. The first has reference to parts of the same whorl;

the latter to parts of different whorls. The term *suppression* is used to express the absence of parts of a flower: sometimes the corolla is suppressed; or the calyx, or the corolla and stamens, &c., or single parts of a series, as a sepal or a petal, may be absent. Now in our typical buttercup there is neither *cohesion*, *adhesion*, nor *suppression*. The flower consists of four series, namely, calyx, which is *inferior* and *polysepalous*; corolla, which is *polypetalous*; stamens, which are *hypogynous*; and pistil, which, being wholly free from the calyx, is *superior*. Now let us take the familiar pea of our gardens. The calyx is in one piece with five teeth indicating the number of sepals which compose the calyx: here is an instance of *cohesion*, the union of like parts of the flower; this union is expressed by the term *gamosepalous*, the sepals being united, from a Greek word meaning 'to marry.' Now let us examine the corolla: it consists of five petals, but as they are unequal we call them *irregular*; the stamens spring from the lower part of the calyx, and hence are termed *perigynous*; a little dissection will show that these stamens are ten in number, that nine are united by their filaments into a kind of membranous expansion, and that the upper one is distinct. This cohesion of stamens in two sets is expressed by the term *diadelphous*, meaning two brotherhoods. Now for the pistil with its pretty little fringed stigma: it is not adherent to the calyx, and consists of a single carpel, as may be seen from the one-celled cavity of the ovary, and the undivided stigma. How may the whole flower of the pea be described? Thus: calyx *inferior*, as it is free from the ovary, and *gamosepalous* because the sepals cohere; the corolla is *polypetalous* and *irregular*, because the petals are free and of different shape and size; the stamens are *perigynous* for they are inserted around the ovary, *decandrous* for they are ten in number, *diadelphous* as they consist of two bundles; the pistil is superior as it is free from the calyx, and *apocarpous* for the

carpel is free, and *monocarpellary* because it consists of a single carpel.

Let us now take the flower of the apple or pear. The calyx is gamosepalous, and the *tube* (that is, its lower united portion) is adherent to the pistil; the corolla is *regular* and *polypetalous*; the stamens inserted upon the calyx are *perigynous* and *polyandrous*; the pistil (ovary) is inferior, because it is adherent to the calyx, and it is *syncarpous* as several carpels are united into one.

In the red or white dead nettle (*Lamium*) the calyx is *gamosepalous* and *inferior*; the corolla is *gamopetalous* and *hypogynous*; the stamens are *didynamous*, because the stamens are disposed in pairs of unequal length; they are epipetalous for they adhere to the corolla; the pistil is *syncarpous* and *superior*.

You will take care to guard the students against being misled by the English names or by the similarity in some particulars of one plant to another. The leaf of the dead nettle resembles that of the stinging nettle, but the flowers are very different indeed: the one belongs to the *Labiates*, the stinging nettle to the *Urticaceæ* order. There are two common species of stinging nettle, the *Urtica urens*, in which the flowers are *monœcious*, that is, the stamens and pistils are on the same plant; and the *U. dioica*, a larger and more robust species, in which these organs are on separate plants, as the specific name indicates. Nettles have no corolla, they have a calyx only; hence such plants are termed *monochlamydeous*, from the Greek *monos*, 'alone,' and *chlamus*, 'a covering;' the same term applies to plants which have a corolla only; while plants which possess both these organs are *dichlamydeous*, i.e. 'having two coverings.' Such plants as possess neither calyx nor corolla, as the willow, are *achlamydeous*, 'without a covering.'

The common arum (*Arum maculatum*) is a curious plant, and much care is necessary if you would understand its structure, which puzzled the great Linnæus himself. There

is a large sheathy leaf called a *spathe*, which encloses a flower-spike called the *spadix*. If you remove the glossy green sheathy leaf, you will see that the flowers are closely packed in rings upon the lower part of this curious spike. First there comes a ring of rudimentary stamens, then one of true stamens, which, however, consist only of sessile anthers, then a ring of barren or rudimentary pistils, after this the true pistils. There is neither calyx nor corolla.

11. **Professor Henslow's schedules.**—These are strongly to be recommended. Here is a specimen of one :—

Organ	No.	Cohesion	Adhesion
Calyx . . . sepals . . .	5	Gamosepalous	Inferior
Corolla . . . petals . . .	5	Gamopetalous	Hypogynous
Stamens . . .	4	Didynamous	Epipetalous
Pistil . . . carpels . . .	2	Syncarpous	Superior
Seeds . . .	One in each of the 4 nuts of the fruit		

White Dead Nettle.

Such schedules can be readily drawn by the pupils themselves, or a number of blank copies could be supplied by any printer at a trifling cost. From the remarks I have made above the explanation of the schedule will be obvious.

12. **Insertion and arrangement of leaves, their parts, and different forms,** will require much time and patience; but do not seek to cram; as I said before, 'hasten slowly,' and remember that definite technical terms are used;

let such terms be taught; and if you are able to illustrate your lessons on the black board by figures of various kinds, you will secure the attention and keep up the interest of the children.

13. **A good knowledge of some typical form is necessary.**—In this chapter I have kept to what relates chiefly to the external forms of a plant with its various parts. I took the buttercup as a type. Of course many other plants would have done equally well. Each teacher may be left to select almost any one he chooses, provided the plant contains all the ordinary parts of the flower—that it be, in fact, *dichlamydeous*.

CHAPTER II.

INTERNAL STRUCTURE OF PLANTS.

FOLLOWING the stages of the Educational Code, I come first of all to the structure of wood, bark, pith, cells, and vessels—a subject of extreme interest, but one not so easy to be taught as that which has reference to the external forms of plants and their parts. Here a microscope is necessary; at least it is necessary that you, the teacher, should have examined the minute structure of plants under the microscope. Diagrams are all very well and most useful as helps, but they are not to be depended upon by themselves; to get an impression which will last on your own mind, you must yourself use the microscope. But there is no doubt a practical difficulty in using a microscope in class-work: only one pupil can look at a microscopic object at a time. I do not forget that triple-bodied microscopes, such as those made by the French optician M. Nachet, exist, so that three observers can look at the same object at one and the same time. My remarks are general. Still I do not see why you should not let the pupils see for themselves specimens of minute structural botany under a good compound microscope; indeed, to produce an abiding impression this is not only desirable, but I think necessary. And now let us say a few words about—

14. **Cells, vessels, pith, and bark.**—What a wonderful thing is the minute vegetable cell! The mighty oak with its hard rugged bark, massive trunk, and outspreading branches, began its infant life as a single cell! It is in the

life-history of the individual cell, first definitely stated by Schleiden, that we find the true basis of vegetable life in general. What a marvel for contemplation, this vegetable cell, this living atom endowed with such extraordinary and diversified power of reproduction! If you will place a tiny bit of stewed rhubarb—but any bit of soft herbaceous plant will do equally well—under the microscope, with a drop of water on the glass slide, using of course a thin glass cover, you will notice a number of hollow sacs more or less cylindrical in form. They may present in different plants almost every possible modification of form; may be globular, oval, squarish, tabular, spindle-shaped, star-shaped, &c. You may here draw a few kinds on the black board. *Of these cells, every part of every plant, be it the softest alga or the toughest tree, is composed.*

And now what are *vessels*, botanically speaking? I scarcely know of any more beautiful microscopic objects than some forms of vegetable vessels. Place a small bit of the fibrous strings of boiled rhubarb in a drop of water under the microscope, using a one-inch objective glass and reflected light; with your dissecting needles you may separate the fibrous bits, and find some long tubes having their cell-walls prettily marked with spiral fibres inside, now closely coiled, now loose.

These tubes are called *vessels*, and they are almost invariably marked by a spiral, netted, dotted, or ring-like thickening upon the inside of their walls. *Vessels then originate from cells, and all plants are built up of cells and vessels.* You may compare with the structure of rhubarb the tissues of oak wood, ripe strawberry, elder pith, shell of walnut ground very thin upon a hone, potato, apple, pine-wood, brake-fern, pollen, &c.

Notice that the cells as long as they take part in the work of the plant contain a fluid, but in old trunks of trees the cells become so very thick-walled that they cease to do work at all.

Draw attention to the difference between cell-contents and cell walls, the real work of the plant being carried on by the cell-contents.

15. **The various contents of the cells,** such as the colourless fluid called *protoplasm*, *chlorophyll*, *starch*, and *raphides*, should not be forgotten in your lessons. Let these words be learnt by heart, spelt on the slates, and explained by the children, after having been described by you. And some of these subjects are attractive enough even to young minds. But how will you so explain that a good impression shall be left on the mind? Well, of course, one can lay down no definite rule, and the point must be left to you to decide. I only give a hint or two in this way.

Take the word *chlorophyll*, for instance. Write it down clearly on the black board; let each pupil spell it; and when sufficient time has been allowed, rub the word out, and make each pupil write it on his or her slate, apart from each other. Now proceed to explain the meaning of the term, from the Greek *chloros*, 'green,' and *phyllon*, 'a leaf;' and let these names with their meanings be similarly taught the class on the black board and slates. Now put such a question as this to the class: What is the colour of grass? Of course the answer will be at once given correctly, and the whole class will exclaim 'green.' Now ask whether any boy or girl had ever turned over a board or a flat stone that had been lying undisturbed for some days on a piece of a grass field. Many would have frequently turned over such a stone or piece of board. What is the colour of the grass underneath? Nearly colourless, varied here and there by a few pale yellow blades. Light, therefore, is necessary to render grass green. Explain then the meaning of the whole word *chlorophyll*, as being the green colouring matter of the leaves or other parts of plants, which consists of little grains floating in the sap of plants, and I think that in this way you will have made your lesson on the word *chlorophyll* both

interesting to the class and likely to be retained on the memory. *This green colouring matter of plants is only formed under the influence of light.* If you place your 'seed-potatoes'—I use the word in a gardener's or a farmer's sense—in a warm place under the influence of light, the 'eyes' will shortly develop leaves which are green; in a dark room, with a similar temperature, growth will indeed take place, but the leaves and leaf stems will develop no chlorophyll.[1] Doubtless other illustrations of this phenomenon will from time to time occur to you. Why does that part of a potato which is covered with the soil show the usual white or brown colour; and why is the top part which is exposed to the sun and air 'green'? It is quite common to see potatoes which are half green and half brown or white. But as there is nothing like an experiment, ask the pupils to test what you have been saying by planting a few potatoes under these two conditions.

I will take only one other cell-content, and that shall be *starch*, a word whose meaning is to some extent known to all your class. The word is simple English, and easily learnt, whereas *chlorophyll* is a compound Greek term, and requires some little time to be learnt and understood; but I maintain that the more difficult word can, with a little patience on the part of the teacher, and attention on that of the learner, readily enough be understood.

The starch of which your class has heard is of course the starch of commerce and domestic life, familiar to the children's mothers and to themselves, who are often sent to buy this useful article. Starch, however, exists in abundance in very many plants; and some of the various forms

[1] The influence of light to develop chlorophyll is a well-known fact, and of general application in plants. In certain forms of low fungoid growths, however, such as the *Bacteria*, it has lately been shown that the influence of light is destructive of the whole life of these microscopic organisms. (*Researches on the Effect of Light upon Bacteria and other Organisms*, by A. Downes and T. P. Blunt; *Proceedings of the Royal Society*, December 6, 1877, p. 488.)

of the starch granules, as they appear within their cells, should be drawn on the black board.

Starch is one of the most abundant of all the cell-contents of plants: potato, sago, and arrowroot starches may be mentioned as among the most familiar examples of starches. As a rule *starch occurs in those parts of the plant which are underground and removed from light*, very different in this respect to chlorophyll as we have seen. There is nothing more easy than the examination of the starch granules and their position in the cells, under a microscope. Make a very thin section of a piece of a potato, place it on the glass slide with a drop of water with a thin glass cover over it. You will see a number of rounded thin-walled, closely-packed cells which are filled with minute oblong granules. Now remove the glass slide; take another and put a very little dry arrowroot and examine it under the microscope, you will notice that though the granules differ from those of the potato somewhat in form, in other respects they are similar. But if you have any doubt about it, add a small drop of weak tincture of iodine; the granules if they consist of starch will become a deep violet colour, as iodine has this effect upon starch.

16. **Bark, pith, and wood: the fibro-vascular system.**—It is absolutely necessary that you make yourself acquainted, by microscopic examination, with the structure of the woody tissue of plants. Cells may be roughly grouped as *short* and *long*; the short cells are found principally in the leaves, are thin-walled, and their office is to elaborate, during spring and autumn, the food of the plant under the influence of light; these short cells are known by the designation of the *cellular* system of the leaf; long cells are generally thick-walled and often taper at each end, forming a firm and tough tissue; these cells with a few vessels form the principal part of wood; they occur in the *petioles* and in the *veins* of the leaves. You can readily observe them in the veins and petioles of the leaves of the greater plantain

(*Plantago major*). Everyone that has broken in two one of these broad leaves, with their thick and tough strings, must have noticed what I am speaking of. You could not select a better plant to show the long and crowded cells. Place a small piece of the elastic thread of this plantain between two glass slides; by pressure and rubbing the thread will separate into a great number of long cells, which are also mixed up with a number of spiral vessels. Bundles of thick-walled cells with their accompanying vessels we speak of as the *fibro-vascular system*; the arrangement of these systems in the stem differs in the two great classes of flowering plants, *monocotyledons* and *dicotyledons*. Take a small piece of the branch of an oak tree about the thickness of a goose quill, and with a sharp knife make a very thin transverse section, and place it in a drop of water with glass cover under the microscope; in the centre is the pith, then comes the wood, which is separated into wedge-shaped bundles by the *medullary* rays; then follow the concentric rings which represent each one a year's growth; so by counting the rings you may ascertain the age of the stem. Now comes a very interesting and important part, namely, a ring or layer of vitally active cells; this is situated between the bark and the wood; it is called the *cambium* ring, the cells of which divide and give off new cells on each side; on the inner side, wood-cells and vessels; on the outer side, fibrous bark or *liber* cells. The bark is made up of three layers, the outer, middle, and inner, which you may verify for yourself by patient dissection under the microscope.

In dicotyledons the fibro-vascular bundles are arranged in the stem in such a manner at a very early stage of the growth, that the cambium cells of the bundles, which are side by side, coalesce, and thus form one continuous cylinder of multiplying and enlarging cells. The consequence is, that in dicotyledons all the *wood* is on the inside of the cambium cylinder, and new wood is deposited on the outside of wood previously formed; all the *liber*, on the other

hand, is on the outside of the cambium, and immediately within the bark, of which, indeed, the liber is regarded as forming an inner layer.

In monocotyledons there is no union of the cambium cells of the fibro-vascular bundles; they become permanently isolated; they form therefore no continuous rings of wood; the bundles are irregularly scattered through the cellular system of the stem, which in consequence receives no additional thickness when once completed. If you will examine a section of the shrub known as butcher's broom—which, by the way, is the only *woody* monocotyledon native in Britain—you will notice the distribution of the fibro-vascular bundles scattered throughout the whole of the cellular tissue. I lay great stress on these personal examinations of the parts of plants, because your teaching will come from you so fresh and full of interest, after that you have patiently investigated each matter yourself. This having been done, you will always be able to suit your lessons and adapt them in your own way to the capabilities of your various pupils.

17. **Food of plants.**—How is a plant nourished? This is a question more easy to ask than to answer definitely. The plant is built up of closed cells and vessels; solid substances therefore cannot be absorbed; fluids, matter dissolved in fluids, and gases alone can enter into the system and nourish the plant. *The root and leaves are the organs through which plants derive nourishment.* The root absorbs water with solids or gases in solution; the leaves, gases and vapours. Let these points be imprinted on the memory.

The substances found in plants must have come to them from, and existed in, their food; but as plants are manufacturers, and make protoplasm and other substances out of simple bodies, we cannot be sure as to the state in which the plant receives its food. Water, as every child knows, has a wonderful effect in reviving withering plants; you can

show by experiments (1) that water evaporates from the exposed surface of plants, (2) that fresh supplies are taken up by the roots, and (3) that the stem serves to convey this water supply from the root to the leaves. When the chemist analyses a plant he finds constantly present these four elements—carbon, oxygen, hydrogen, and nitrogen—which exist probably in every organised being, whether animal or vegetable; but these four elements exist in the plant not in a separate state, but in combination. The terms *ternary* and *quaternary compounds* should be understood. When, for instance, the carbon is united with oxygen and hydrogen, there being three elements, the term *ternary compound* is employed; when another element, namely nitrogen, combines with the above-named three elements, the term *quaternary compound* is made use of. Carbon, represented in its separate state by *soot*, is the most abundant element in *the dry substances* of plants. Carbon, hydrogen, and oxygen are present in the product of the life of the plant; in starch and cell-membrane these three elements occur; in protoplasm nitrogen also occurs in combination. Certain substances in solution are absorbed by the root of the plant; after burning a plant, an *ash* remains, which is indestructible by heat. Sulphur, phosphorus, soda, lime, and silex or flint, are the substances most generally found. Plants take in air through their leaves; they absorb carbonic acid gas, for instance, from the atmosphere, retaining the carbon, and at the same time setting free the oxygen. Show this by a simple experiment. Sink a few leaves, soaked previously in water, in spring water, and expose to direct sunlight. Bubbles of oxygen will be given off in a rapid and continuous stream. A portion of the epidermis of the leaf of a plant, showing the curious little organs known as *stomata*, by means of which the plant absorbs gases and probably vapour from the air, it would be desirable to show your class under the microscope.

Plants as animal-feeders.—You will greatly interest your pupils by calling their attention to the fact that certain plants are able to catch insects and feed upon their juices. The common sun-dew (*Drosera rotundifolia*), often found in boggy ground amongst the moss called *Sphagnum*, is an instance of a British animal-eating plant. Small bits of albuminous matter (as the white of egg), when placed on the leaves of the sun-dew, gradually disappear by absorption—and the food agrees with the plant; some substances, however, such as cheese, prove very injurious to its health; and the plant, under such a treatment, gradually grows black and dies.

The curious *Sarracenia* and *Darlingtonia* of North America, and Venus's fly-trap (*Dionœa muscipula*) of the sun-dew family (*Droseraceæ*), are insect-feeders. It is most curious to witness the closing of the *laminæ* of the leaves of this latter plant when the three irritable hairs are touched. You should read Mr. Darwin's book on this subject. (*Insectivorous Plants*, Murray, 1875.)

18. **Growth of plants.**—I have already spoken of the important part which the cambium ring plays in the growth of a dicotyledonous plant. The ascending sap circulates from cell to cell by *diffusion*, perhaps through the younger layers of wood, and finds its way to the leaves. The *elaborated sap*, which has undergone certain chemical changes under the influence of the sun, is thought to descend chiefly through the inner layers of bark, so that new protoplasm is formed out of this elaborated sap; the cambium ring produces new cells, and thus adds to the growth of the stem, by the deposition of new matter. The new substances elaborated in the leaf are wanted for the growth of the plant at the tip of every shoot where new buds are being formed, at every part of the circumference of the stem and branches, and in parts below the stem where new rootlets are being formed.

That the active processes of a dicotyledonous woody plant are carried on chiefly through the inner layers of the bark or the contiguous outer layers of the wood, is evident from the fact that a tree whose central part has been destroyed is able to live and put forth new leaves and branches. Again, if you take away a ring of bark from the stem of a tree, or bind it round tightly with a strong iron hoop, so as to stop the circulation, so to speak, no new wood will be formed below the stripped-off portion of the bark or the iron hoop; but above it a considerable thickening will take place.

19. **The functions of the root, stem, and leaves of a plant,** therefore, are chiefly these. *The office of the root is to obtain food from the soil or water, in a liquid state, for the growth of the plant.* This is the general rule; at the same time, you will remind your pupils that there are plants which develop roots from their stems in the air, such being called aerial roots. This we see in the common ivy and some other climbing plants; certain exotic orchids produce none but aerial roots which never reach the soil, and cannot therefore extract food from that source; they often grow on other plants, but they do not derive nourishment from them; hence they must draw their food from the air and vapour with which they are surrounded.

Plants which send their roots into the substances of other plants take their nourishment from them; these are true *parasites*, of which the mistletoe is a familiar example. Those which merely grow on other plants, and take no food from them, are called *epiphytes*.

The office of the root, in almost all cases, is to extract nourishing matter for the growth of the whole plant from the soil, water, or the air; and sometimes from the juices of other plants, which they thus manage to destroy. *The function of the stem is to transmit the nutrient fluids upwards to the branches and leaves, and to receive the elabo-*

rated sap of the leaves into its tissues, to produce cambium, and add to its own growth. Some stems, however, are more like roots in appearance, and popularly are called roots, such as the turnip, carrot, potato, lily, hyacinth, which are subterranean stems of a more or less globular or conical form. In all these cases of underground stems there is a quantity of starch stored up within their substances which serves as nutriment for the plant during a subsequent period of growth.

The function of the leaf is to take in supplies of food from the air or the water; it decomposes the carbonic acid gas by the fixation of the carbon and the liberation of the oxygen; it produces certain chemical changes in the sap which are necessary for the health and growth of the whole plant.

20. **Functions of the different parts of the flower.**—What has been said hitherto has reference to the organs of nutrition in plants; we come now to the different parts of the flower, and these relate to the reproductive organs in plants. Many plants are able to live and grow for a long time, others for a short time; but all have a limit to their life-duration, all must die sooner or later. Hence they must depend for the continuance of their kinds on the processes of *reproduction.* This subject is of great interest, and one which admits of easy explanation to your class. The forms of these parts of a flower, as occurring in a common buttercup, have been briefly noted in our first chapter. Draw attention to the fact that *the stamens, the pistil, and the ovary are the essential parts of every flower*; as it is by their means that the seed or seeds are produced which are able, under favourable circumstances, to develop into new plants, resembling their parent forms. The sepals and petals, although, in a later stage of the life of the flower, of no use to the plant, are at first very serviceable to it by enveloping the tender, delicate, and immature stamens and

ovaries, and thus preserving it from injury. Look at that poppy-bud; how tightly wrapped are the internal parts of the flower by the two closely-pressing sepals and twisted petals! In a short time, when the pollen dust is ripe and the ovary ready for fertilisation, the calyx and corolla will fall off. The petals of the corolla, moreover, have a very decided effect on the vigour, beauty, and sometimes even on the very existence of the plant; according as the petals are bright and richly coloured, more numerous or more certain will be the visits of insects to them. It is well known that it is often of great advantage to the plant to have the ovules of one flower fertilised by the pollen of another, rather than by that of the same flower. An insect visits a plant, being attracted by the colour, for the purpose of sipping its juices; as it dips its head and proboscis within the open flower, it gets dusted about its fore parts with the pollen from the anthers; off it flies to a plant of similar kind, and in dipping into it, some of the grains of the pollen are almost certain to be left on the top of the ovary, by and by to descend that organ by means of its elongated tubes, and to fertilise the ovule at the bottom. It has been found that plants which have thus been fertilised by insects carrying pollen from one plant to another are more vigorous and produce flowers of brighter colours than self-fertilised plants. *You may draw attention to the fact that in some cases flowers have actually lost the power of self-fertilisation, inasmuch as the stamens ripen before the pistil*; so that if it were not for insect agency some plants would cease to exist altogether.

The beautiful narrow-leaved willow herb (*Epilobium angustifolium*), for instance, does not mature its pistil until the stamens have shed their pollen; its bright reddish pink flowers, familiar to you perhaps as a cottage garden plant, if not as a wild flower, attract bees and other insects, which coming from other plants whose stamens have ripened their pollen later, convey it to another plant, and thus ensure

fertilisation. I would strongly advise you to procure Sir John Lubbock's manual, 'On British Wild Flowers considered in Relation to Insects.' (Macmillan, 1875.) If you have not read it, I can assure you that you have an intellectual treat in store of a very high order, and one which will last you for very many years.

CHAPTER III.

THE COMPARISON OF A FERN AND A MOSS WITH A FLOWERING PLANT.

It would be well for the pupils to learn the technical terms which are used to express the two great divisions of the Vegetable Kingdom, viz., *Phanerogams* or *Phænogams*, and *Cryptogams*. For all plants are either flowering or flowerless: the two first terms denote in Greek those plants whose reproductive organs are manifest, and the second are those whose reproductive organs are concealed. Ferns, mosses, algæ (both of the sea and fresh water), fungi, lichens, have no flowers at all, but they possess reproductive organs peculiar to themselves, different from but analogous to organs essential to the flower. In most cases they are so disguised, and often so simple, that they have only been, comparatively speaking, but recently recognised as the reproductive organs. *No cryptogamic plant produces pollen or ovules, and therefore no such plant is multiplied by seeds.* Let us take a glance backwards. All the plants in the first great division produce seeds containing an embryo with one or more rudimentary leaves called *cotyledons.* There may be two of these seed-leaves, as in *Dicotyledons*; or there may be only one, as in *Monocotyledons.* The *Cryptogams*, having no cotyledons, are termed *Acotyledons.* The more important families of flowerless plants may be divided into two divisions: (1) Those which possess a distinct stem and leaves, such as ferns (*Filices*), club-mosses (*Lycopodiaceæ*), horsetails (*Equisetaceæ*), and mosses (*Musci*). (2) Those which have no distinct stem and leaf, such as mushrooms, toadstools,

moulds, &c. (*Fungi*), lichens (*Lichenes*), and sea-weeds (*Algæ*). With regard to the lichens, Schwendener, Bornet, and some other botanists have recently asserted that lichens are merely algæ attacked by some parasitic growth of fungi. But most botanists maintain that this is not the case, that the lichens are a distinct family of plants, and I think that they are right. We have already seen that flowering plants consist of cells and possess a fibro-vascular system, and that they reproduce themselves by manifest organs, as by stamens and pistils. In the flowerless plants there is, generally speaking, no fibro-vascular system; they consist entirely of cells. In ferns, however, there is an approach to a fibro-vascular system, as also in the *Equisetaceæ* and *Lycopodiaceæ*. If, for instance, you make a thin section of the footstalk of a fern-leaf, you will find that the stem is for the most part made up of cellular substance, which is separated into a cortical and a medullary portion by the interposition of a circular series of fibro-vascular bundles containing true woody tissue and ducts; these ducts show on their walls regular markings, which, from their resemblance to the rungs of a ladder, are called *scalariform*. It would be easy to show the structure to your class under the microscope. Now the stem of ferns differs from that of dicotyledons and monocotyledons in the mode of growth; it increases solely by additions to its summit, and in the arrangement of the fibro-vascular bundles, which form an interrupted circle around a cellular axis which usually decays, so that old stems become hollow. As fern-stems grow by successive additions to the extremity only, ferns have been termed *Acrogens*, i.e., point-growers. You will of course draw the attention of your class to the fructification of ferns, and show how in different genera the disposition of the fructification varies. It is borne almost invariably on the under surface of the frond. Take as example the little clusters on the male shield fern (*Aspidium Filix-mas*), which are brown when ripe, and called *sori*; there are two rows of *sori* upon, at least, the lower

lobes (*pinnules*) of each of the *pinnæ* of the frond. At first these little clusters are protected by a pale-coloured membrane, *reniform* or kidney-shaped, called the *indusium*, which at length withers and exposes the minute stalked *sporanges*, of which each little cluster, or *sorus*, is composed. The black powdery granules in each capsule, or sporange, form the *spores*, very minute microscopic bodies. If you place a frond of male fern upon a sheet of white paper, with its spore-producing surface touching that of the paper, soon the whole paper will be thickly covered with the spore dust. You must draw attention to the distinction between a *spore* and a *seed*. A spore consists of a single cell, and contains no embryo ; a seed always contains an embryo. The ovule of a flowering plant is fertilised by the pollen of the stamens. How is the spore of the fern produced? The subject of the germination and development of spores is one of singular interest ; and one which with care and patience you may successfully study yourself. Break a few bits of sandstone off a large lump, so as to expose a fresh surface upon which there cannot be any already existing minute vegetable growth ; place them each one separately in a saucer with a little water ; with a camel's-hair brush place a little of the spore dust on the sandstone bits, and cover with a tumbler. Keep your specimens in a tolerably warm room, but do not expose them to direct sunlight. In the course of a few days or weeks, as the temperature varies, the stone will be thickly covered with a delicate green efflorescence resembling the fine pile or plush of green velvet. These are the germinating spores, called in this stage and for some months afterwards, *prothallia*, i.e., 'first leaves.' When these prothallia are sufficiently advanced in their growth, small circular vesicles, each about the size of the whole original spore, will be seen to stud either the edge or the under surface of the little prothallia. Now these are the antherozoidal cells ; so called because they contain very minute little bodies, endued with active motion like animals, which perform a function

analogous to that of the *anther* in phanerogamic or flowering plants. Upon the prothallium there appear other cellular organs called *archegonia*, 'first offsprings;' into these cells the little corkscrew-like bodies of the antheridia descend and fertilise the germinal cell, just as the anther's pollen fertilises the germ-seeds through the channel and instrumentality of the stigma and pistil.

21. **Mosses.**—You may take as a type of the moss family the large and common hair-moss (*Polytrichum commune*); draw attention to the numerous leaves and slender but tough wiry stems. *There is no approach to a vascular system in mosses*; vessels are absent both from leaves and stem; their tissue is entirely cellular. These little plants absorb nutriment from the soil by means of their delicate root-hairs, which consist of long tubular transparent cells. The little capsule or urn, borne at the top of a long footstalk (*seta*), is called a *sporange*, which at first is covered by a cap called a *calyptra*, which with the finger and thumb you may remove; you then find the urn closed by a lid (the *operculum*), which when ripe separates and exposes a row of little teeth around the margin of the sporange; these marginal teeth form what is termed the *peristome*. These sporanges contain the spores, which when ripe are able to develop the complete vegetative system of the plant. Mosses possess *antheridia* and *archegonia* analogous to but different in structure from those of ferns. The spores contained in the sporangium are the product of the action of the *antheridium* upon the *archegonium.*

22. **The formation of different kinds of fruits.**—The word 'fruit' in ordinary language generally denotes the juicy products of certain plants; *in Botany the fruit is defined as that part which produces a seed or seeds in flowering plants, or spores in flowerless ones.* The formation of a fruit in flowering plants commences with the fertilisation of

an ovule by a pollen tube. There are many plants which produce buds, flowers, and fruit almost at the same time; so that in one species of plant you will be able to set before your class the whole transition, from the first fertilisation of the ovules of the ovary to its complete form as ripened fruit. Essentially the fruit consists of the mature ovary or ovaries, but other parts of the flower also frequently enter into its composition. In the apple and gooseberry, for instance, the calyx adheres to the ovary and forms part of the fruit. Take an apple or a pear: what is that withered brown part at the top? Clearly it is the remains of the calyx, and you can count the five sepals and notice the shrivelled up stamens. The fruit of the apple or pear, therefore, as of many other kinds of fruit, is said to be *inferior*. In this case the ovary and calyx tube together constitute the *pericarp*, i.e., that portion of the fruit formed of the ovary and whatever adheres to it exclusive of and outside of the seeds. Show an orange. What do you find at the top? A little round brown scar, which is the remains of the style of the pistil. What do you notice at the bottom of the orange? The scar of the calyx, or perhaps the calyx itself adhering. The orange, therefore, in technical botanical language, is a *superior* fruit, and has been developed solely from the ovary of the flower. Cut the orange in two; you will find it is divided into a variable number of little chambers or cells by certain membranous dissepiments, each cell representing a carpel. In the pulp of the cells the seeds are imbedded. Take a strawberry: the calyx is persistent, being that portion you hold in your finger and thumb when you bite off the succulent part of the fruit. What are those little seed-like bodies embedded in this succulent mass, and what part of the plant, botanically speaking, is the succulent mass itself? Under a lens you will see that each little seed-like body bears near the top the remains of the style; cut one open; the seed is found inside; so that each little seed-like body is botanically the true fruit; it consists of an

indehiscent pericarp and an enclosed seed. But what is that luscious part which in ordinary language we call the fruit of the strawberry? Technically it is no part of the fruit, but gastronomically it is the only important part of the plant. The rounded pulpy mass is in botanical language the *receptacle*, or that part of the peduncle above the calyx upon which, when in blossom, the corolla, stamens, and ovary were inserted. Take a dandelion with its numerous so-called seeds and feathery appendages, blow them away; notice the *receptacle* upon which the fruit, consisting of a one-celled ovary with single seed, rested, and compare it with the juicy receptacle of the strawberry.

The terms *apocarpous* and *syncarpous* should be explained. Take a buttercup: the carpels are all free and distinct; the pistil is *apocarpous*. Take a poppy: the carpels or ovaries are united into one compound body; the pistil is *syncarpous*. The prevalent forms of fruit, whose forms should be carefully studied, are :—

23. **Simple fruits** (resulting from a single flower):—*Achene*, apocarpous, dry, indehiscent, usually one-seeded, as in buttercup, rose, strawberry; *nut*, properly syncarpous and indehiscent, the pericarp usually hard and bony, as in the hazel; *drupe*, usually apocarpous, succulent, indehiscent, and one-seeded, with the inner layer of the pericarp stony, as in cherry, peach, almond; *berry*, syncarpous, succulent, indehiscent, several, or many-seeded, as in gooseberry, currant, grape; *capsule*, syncarpous, dry, dehiscent, as in primrose, chickweed, tulip, orchid, violet, horse-chestnut.

24. **Collective fruits** (resulting from two or more flowers), as in the mulberry, fig, and cones of the pine, larch, and cedar. (See Professor Oliver's 'Lessons in Elementary Botany.')

The term *placentation* should be understood. The *placenta* is that part of the inside of the ovary to which the

ovules are attached. Placentation may be either *axile*, when the ovules are attached to the axis or centre of the ovary, as in tulip and foxglove ; *parietal*, when the ovules are attached to the inner surface of the cavity of a one-celled compound ovary, as in violet, pansy, &c.; *free central*, where the placentation is axile, but the dissepiments are lost before the ovary is fully grown, so that the ovules are collected in a head in the centre of a one-celled ovary ; this may be seen in pinks and stitchworts.

25. **The structure of a bean and of a grain of wheat.**—If you will plant a few beans and allow them to remain in the ground from three to ten days, and dig them up at intervals, and show from actual specimens the process of development, you will stir up the greatest interest in your class. The split bean soon shows the embryo developing *plumule*, *radicle*, and *cotyledonous leaves*. At first the plumule is colourless ; under the influence of light it assumes a greenish colour. You will notice the outer coat, the *testa*, which soon peels off after the seed has been in the ground or in water for a short time; the cotyledons, or seed leaves, so thick and fleshy, made up of starch and albuminous material, whose function it is to nourish the young plant, will not escape your attention, and should be shown from growing seeds. The bean will afford you a good type of germination in a dicotyledonous plant. Take some grains of wheat, a monocotyledonous plant, soak them in water. How does a grain of wheat differ from the bean seed? The bean seed is truly and simply a seed ; the grain of wheat is a fruit consisting of a pericarp and seed, though the pericarp is closely adherent to the true seed. In dicotyledons generally the seeds are free from the pericarp. Cut the grain open, you will find the embryo near the base ; it has one cotyledon and shows plumule and root-buds. The main body of the wheat grain is filled with a starchy albu-

men, hence it is said to be *albuminous.* Seeds like the pea and bean contain an embryo only, and are *exalbuminous.*

Germination, or the first stage of the growth of a plant, may be readily seen by placing a few beans under moist earth. You will draw attention to the essentials to germination, namely, a certain amount of moisture, warmth, and air. After a certain stage of growth light is necessary. The light influences certain chemical changes; starch is converted into soluble sugar, and albuminous substances are formed. I must leave it to yourself as to what extent these points, involving a certain amount of chemical knowledge, should be brought before the attention of the pupils.

26. **Classification.**—Pupils should learn a habit of grouping plants and placing them in their natural orders or families. I would recommend that they should gather for themselves a number of different British wild plants and arrange them, in a general way, under their respective orders. But this part of botanical teaching comes last of all. The classification of the principal groups of flowering plants, such as (1) *Angiosperms,* or plants having seeds contained in closed carpels; and (2) *Gymnosperms,* naked-seeded plants; the chief orders of *Monocotyledons,* as grasses, sedges, flags, amaryllids, orchids, lilies, &c.; and those of *Dicotyledons*—you will bring before the attention of your pupils, as circumstances require.

Some orders of plants consist of species which bear a striking resemblance to each other, as the *Labiatæ* and the *Leguminosæ.* Begin in classification with these. The pupils will advance from what is obvious to what is more or less obscure. Some orders contain genera or species which vary from the typical form to a considerable extent. Do you know the butcher's broom (*Ruscus aculeatus*)? Would you be surprised to learn that this plant belongs to the *Liliaceæ* or lily order of plants? You may draw attention to such aberrant

forms, but I must leave it to yourself and the particular circumstances under which your school is placed to decide how far you should bring before the pupils aberrant forms of plants.

27. **In conclusion,** remember that in following out the directions of the Code you are trying to place your pupils in the position of those who are forming a scaffold merely for a future erection. You have to train the mind so that it can acquire for itself, in after time, fresh additions of plant knowledge. You are not to 'cram' into the pupil a lot of crude undigested material, but to prepare him for assimilating certain known facts to his own mental condition.

CHAPTER IV.

HOW TO DESCRIBE PLANTS.

PROFESSOR OLIVER gives a few examples of how to describe plants in the appendix to his 'Lessons in Elementary Botany.' Let us take his description of the garden pea, a *dicotyledon*, and of the common wheat, a *monocotyledon*, and let the student go carefully through each point of the description with specimens of the plants before him.

GARDEN PEA. *Pisum sativum.*

Class—DICOTYLEDONS. Division—CALYCIFLORÆ.

A weak climbing annual herb, with alternate stipulate compound leaves ending in tendrils and irregular (papilionaceous) flowers.

ROOT fibrous, branched.

STEM weak, climbing, slightly branched, glabrous.

LEAVES cauline, alternate, pinnate (bi-tri-jugate), terminating in tendrils (metamorphosed leaflets); *leaflets* ovate, entire, glabrous, glaucous; *stipules* foliaceous, ovate-cordate, slightly crenate.

FLOWERS large, irregular (papilionaceous), in 2-3-flowered, axillary, pedunculate racemes.

CALYX gamosepalous, 5-toothed, bilabiate, persistent.

COROLLA papilionaceous, white; *vexillum* large, broadly obcordate, erect; *alæ* roundish, converging, shorter than the compressed, curved *carina*.

STAMENS perigynous, decandrous, diadelphous; *filaments* subulate above; *anthers* 2-celled, dehiscing longitudinally.

PISTIL apocarpous, monogynous: *ovary* superior, oblong, compressed, 1-celled; *style* terminal, subfalcate; *stigma* simple; *ovules* few, attached to the ventral suture.

FRUIT a legume; *seeds* few (3-9), globose, exalbuminous, with a coriaceous glabrous testa.

COMMON WHEAT. *Triticum vulgare.*

Class—MONOCOTYLEDONS. Division—GLUMIFERÆ.

An annual corn-plant, with erect, distichous, spicate inflorescence.

ROOT fibrous.

STEM erect, jointed, terete, striate, glabrous.

LEAVES cauline, alternate, sheathing, linear, acuminate, striate, slightly scabrous above; *sheath* terete, striate, glabrous; *ligule* very short, truncate, membranous.

INFLORESCENCE spicate, 3-4 inches long, tetragonous, rachis compressed, ciliate; *spikelets* alternate, distichous, compressed, 5-9-flowered, sessile, attached by their sides to the rachis.

OUTER GLUMES nearly equal, coriaceous, ovate, ventricose, obliquely subcarinate, obtuse, apiculate, glabrous.

FLOWERING GLUME ovate-oblong, coriaceous, ventricose, obscurely 7-9-nerved, aristate.

PALE equalling the flowering glume, narrowly oval, obtuse, bicarinate with inflexed margins, angles minutely ciliate.

STAMENS triandrous, hypogynous; *filaments* capillary; *anthers* versatile, linear, bilocular, dehiscing longitudinally.

LODICULES 2.

PISTIL syncarpous; *ovary* superior, 1-celled, globose; *styles* 2; *stigmas* plumose; *ovule* solitary.

FRUIT a free caryopsis; *embryo* at the base of mealy albumen.

Take a specimen of the common male shield-fern in autumn, and compare it with the following description in Bentham's 'Handbook of the British Flora' (p. 629):—

MALE SHIELD-FERN. *Aspidium Filix-mas*, Sw.

Rootstock short but thick, woody, and decumbent or *rising* sometimes obliquely a few inches from the ground. Fronds handsome, in a large circular tuft, 2 or 3 feet high, stiff and erect, broadly lanceolate, with the lower pinnas decreasing, as in most *Shield-ferns*, regularly pinnate; the pinnas deeply pinnatifid or pinnate; the segments regularly oblong, slightly curved, very obtuse, slightly toothed, connected at the base or the lowest ones distinct; the main stalk very shaggy with brown scarious scales. Sori rather large, near the base of the segments, with a conspicuous, nearly peltate or kidney-shaped indusium.

GLOSSARY, OR EXPLANATION

OF SOME OF THE MOST COMMON OR IMPORTANT BOTANICAL TERMS.

Abortion, imperfect or rudimentary development.

Acaulescent, without an evident stem.

Accrescent, applied to parts of the calyx or corolla which continue to grow after flowering.

Accumbent, applied to the seeds of *Cruciferæ* which have the radicle curved over the edges of cotyledons.

Achene, a dry, one-seeded apocarpous fruit, or seed vessel which does not split open (Gr. *achēn*, 'poor or deficient').

Achlamydeous, applied to plants which have neither calyx nor corolla.

Acicular, needle-pointed.

Aculeate, furnished with prickles; having *aculei*, i.e. prickles on the *bark*, as in bramble and rose—not on the *wood*, as in hawthorn, which is spinose.

Acuminate, having a long point.

Adhesion, a term to denote the union of unlike parts of the flower of a plant, as the union of the corolla to the stamens, ovary to calyx, &c.

Adnate, when one organ is united to another; applied also to the anther, when the filament is prolonged up its back.

Æstivation, the position or arrangement of the parts of the flower in the flower-bud; from the Latin *æstas*, summer, the season when buds are produced.

Alæ, the wings or lateral petals of a papilionaceous flower.

Albumen, the solid substance or nutritious matter stored up with the embryo.

Alburnum or sapwood, the outer young wood of a dicotyledonous plant, taking a principal part in the upward conveyance of sap (Lat. *albus*, 'white').

Alternate, when a single leaf is given off at each node the leaves are said to be alternate.

Amentum, a catkin or ament, a deciduous unisexual spike (Lat. *amentum*, 'a thong').

Amplexicaul, when the base of a sessile leaf clasps the stem.

Anatropous, an inverted ovule, so that the micropyle adjoins the hilum, and the *chalaza*, or the base of the ovule, is at the opposite end.

Andrœcium, the male organs of a flower collectively.

Angiospermous, plants which have seeds contained in a seed-vessel.

Annual, applied to plants which die the first season after flowering.

Anther, the part of the stamen which bears the pollen.

Antheridium, the male organ in cryptogamic plants, answering to the anther in phanerogams.

Antherozoa, the filaments of an antheridium, which move about like animalcules.

Apex, the point of a leaf or leaflet at which the midrib ends.

Apiculus or *Apiculum*, a terminal point springing abruptly, as in a leaf.

Apocarpi, a section of mosses which have their fructification on the summits of the branches.

Apocarpous, when the ovary and fruit are composed of numerous distinct carpels, the ovaries and carpels being free.

Apothecium, applied to the fructification of lichens; the open, rounded, or shield-like discs which bear the *thecæ* or spore-cases.

Arachnoid, applied to fine hairs entangled like some kinds of cobweb.

Archegonium, the female organ in cryptogams, corresponding to the ovule or embryo-sac of phanerogams.

Aril, *Arillus*, an extra coat growing wholly or partially over the testa or thin membranous shell of certain seeds developed from the funicle or micropyle, as in the bright orange-coloured coat of the seed of the spindle-tree (*Euonymus*) (Low Lat. *arillus* (*aridus*), 'dry').

Aristate, having an arista or awn, a long, pointed process attached to the scales or glumes of barley, some varieties of wheat, and many grasses.

Ascus, applied to the spore-containing vessels, or bags, forming the fructification of certain fungi and other cryptogamic plants.

Auriculate, having ear-like appendages.

Axile, applied to placentation when the ovules are attached to the *axis* or centre of the ovary.

Axillary, buds borne in the axis of leaves, *i.e.* the angle where the leaf joins the stem.

Axis of a plant, consists of the descending root and the ascending stem.

Bark, the outer cellular and fibrous covering of the stem, composed of three layers; separable from the wood in dicotyledons.

Basidia, cells bearing on their exterior spores in some fungi.

Berry, any syncarpous succulent fruit which does not open (indehiscent) to allow the seeds to fall out, as grapes and currants; hence, botanically, strawberries, raspberries, and mulberries are not true berries at all.

Bidentate, having two teeth.

Biennial, producing seed and dying in the second season.

Bifid, applied to leaves when they are two-cleft, or cut deeply into two parts. See *Bipartite*.

Bifoliate, having two leaflets.

Bilocular, applied to anthers and ovaries which have two cavities or *loculi*.

Bipartite, of leaves, when they are cut down to near the base into two parts; the incision is deeper than that implied by the term *bifid*—which see.

Bipinnate, twice-pinnate; when the common petiole bears secondary petioles upon which the leaflets are pinnately arranged.

Biternate, twice ternate, a compound leaf divided into three, and each division again divided into three.

Blade, the broad part of a leaf, as distinguished from the stalk or petiole.

Bract, a small leaf, or leaf-like organ, bearing one or more flowers in its axil.

Bracteate, applied to flowers when they spring from the axils of bracts.

Bracteole, a little bract at the base of a separate flower of an inflorescence.

Bud, an undeveloped branch, leaf, or flower.

Bulb, an underground stem with suppressed internodes covered by scaly leaves, as of a hyacinth, onion, &c.

Bulbel, or *bulbil*, or *bulblet*, a small bulb, or axillary bud, which falls away from the parent, and is able to develop into a separate plant, as in some lilies, and in the figwort buttercup.

Caducous, falling off early; spoken of certain organs of a flower, as, for instance, the calyx of the poppy.

Cæspitose, growing in tufts, or tufted.

Calcar, a spur or projecting process from the base of an organ, as in the corolla of the larkspur.

Calceolate, slipper-shaped, applied to the hollow petals of some orchids.

Calyciflora, a sub-class or division of polypetalous dicotyledons, which have the stamens attached to the calyx.

Calyptra, the little cap, or hood, which covers the sporangium in mosses.

Calyx, the outer envelope of the flower formed by the calyx-leaves or sepals.

Cambium, a viscid secretion between the bark and young wood, a cellular mass of protoplasm or formative matter, the inner part

making new wood, the outer new bark. The word is derived from the non-classical Latin 'cambire,' to exchange, barter. The noun *cambium* occurs in mediæval Latin, meaning 'change;' it was used to denote a liquid which becomes glutinous—hence its application to the viscid secretion formed in trees in the spring and early summer.

Campanulate, bell-shaped.

Campylotropous (*campylos*, curved, and *tropē*, a turning), applied to ovules which are so curved as to bring the hilum, micropyle, and chalaza, or base of the nucleus, near each other.

Capillary, hair-like.

Capitulum, a head of flowers in Compositæ.

Capsule, a dry seed-vessel, dehiscent, opening by valves, teeth, pores, or a lid.

Carina, the keel of papilionaceous flowers.

Carpel, *Carpellary leaf*, the hollow leaf forming the pistil.

Caryopsis, the fruit of grasses, the pericarp being adherent to the seed.

Catkin. See *Amentum*.

Caudicle, the slender process or stalk which bears the pollen-mass in orchids.

Cauline, applied to upper leaves which spring from the stem.

Centrifugal, applied to inflorescence when the peduncle or axis terminates in a flower, same as *definite* or *cymose*.

Centripetal, when the principal axis never terminates in a flower, but gives off a succession of lateral pedicels; same as *indefinite*.

Cernuous, nodding, pendulous.

Chalāza, the part of an ovule where the base of the nucleus is united to its coats, the base of the nucleus (Gr. 'hail,' 'a pimple').

Chlorophyll, the green colouring matter of the stem or the leaves.

Cilia, hairs fringing the margin of a leaf; the vibratile hairs of zoospores

Cinenchyma, branching vessels containing white or coloured fluid (milk-sap) (Gr. *kineo*, 'I move,' and *chuma*, 'that which is poured').

Circinate, rolled or curled up like a crozier, applied to the vernation of ferns.

Clavate, club-shaped, thickening towards the top.

Claw, the narrow part at the base of a petal.

Coccus, the one-seeded carpel of a syncarpous fruit whose carpels separate when ripe.

Cohesion, the union of like parts of a flower.

Columella, the column or central organ in the sporange of mosses.

Commissure, the union of the faces of two achenes in the fruit of Umbelliferæ.

Complete, applied to flowers when all the organs—as calyx, corolla, stamens, and pistil—are present.

Compound, applied to leaves which are divided into distinct leaflets.

Conceptacle, a closed cavity containing the reproductive system of spores and antheridia, at the end of the fronds in some cryptogams, as in the *Fuci* (seaweeds).

Conduplicate, folded down the middle.

Connate, applied to leaves, when the bases of two opposite leaves are united on each side of the stem.

Connective, the part of the anther which connects the pollen-bearing lobes.

Convolute, leaves rolled inwards from one edge.

Cordate, heart-shaped, with the broad part of the heart next the stem.

Corm, the underground thickened base of the stem of some herbaceous plants, as the crocus and arum.

Corolla, the inner envelope of the flower, formed by the petals.

Corona, an appendage of the envelopes of the flower, as the wide projecting tube in the daffodil.

Corymb, a raceme of which the lower pedicels are much longer than the upper ones.

Cotylēdon, the temporary lobe, or seed-leaf, of the embryo.

Cremocarp, the fruit of Umbelliferæ, composed of two separate mericarps (Gr. *kremao*, 'I suspend,' and *carpos*, 'fruit').

Crenate, applied to the margin of a leaf which has rounded teeth.

Cryptogamic, applied to plants whose organs of reproduction are obscure.

Cucullate, bearing a hood, formed like a hood.

Culm, the stem or stalk of grasses.

Cuneate, wedge-shaped.

Cupule, the cup-like involucre of Corylaceæ, as that formed by the aggregated bracts of the acorn.

Cuspidate, having an abrupt, acute point.

Cyme, an inflorescence in which the peduncle or axis itself terminates in a flower (Lat. *cyma*, 'the young sprout of a cabbage').

Decandrous, having ten stamens.

Deciduous, falling off early.

Declinate, applied to stamens when directed to one side, as the stamens of amaryllis.

Decumbent, applied to stems lying flat on the ground, then suddenly rising at the apex.

Decurrent, applied to leaves when the margins of the blade are continued down the sides of the stem.

Decussate, opposite leaves crossing each other in pairs at right angles.

Definite, applied to inflorescence when it terminates in a single flower. See *Cyme*.

Dehiscence, mode of opening of an organ, as of an anther, or seed-vessel.

Dentate, applied to leaves when their margins have sharp teeth directed outwards.

Denticulate, finely-toothed.

Determinate, applied to definite or cymose inflorescence.

Dichlamydeous, having calyx and corolla.

Dichotomous, forked, stem dividing by twos.

Diclinous, flowers with stamens only, or with pistil only (Gr. *dis*, 'two,' and *klinē*, 'a bed').

Dicotyledons, when the embryo has two cotyledons.

Didynamous, applied to stamens when there are two long ones and two short.

Diffusion, the circulation or transference of fluids or gases from cell to cell.

Digitate, applied to compound leaves, when the leaflets are attached to one point, as in the horse-chestnut.

Digynous, having two styles.

Dimerous, flowers with parts in twos.

Dimorphous, when similar parts of a plant assume different forms, as in the different relative lengths of stamens and pistils in different individuals of the same species, as in some kinds of flax, and in the primrose.

Diœcious, having staminate and pistillate flowers on different plants.

Disk, the small florets with regular corollas in the centre of the flower-heads of the Compositæ, as in the yellow tubular florets of the daisy.

Dissepiment, a division in the ovary.

Distichous, in two rows, on opposite sides of a stem.

Distractile, applied to anthers when the lobes are widely separated from each other.

Dorsal, applied to the suture of the carpel which is farthest from the axis.

Drupe, a fruit consisting of a succulent outer layer of pulp or flesh, and a stony pericarp containing a seed, as a cherry, apricot, &c. (Lat. *drupa*, 'an over-ripe olive').

Duramen, the heart-wood or matured central portion of dicotyledonous trees.

Ebracteate, applied to flowers when the bracts are undeveloped.

Elăters, elastic spiral fibres in the spore-cases of certain cryptogams, as in the Hepaticæ, or liverworts, which disperse or drive away the spores (Gr. *elatêr*, 'a driver').

Emarginate, when the point (*apex*) of the leaf has a shallow notch.

Embryo, the minute body or germ of the future plant contained in the seed.

Embryo-sac, the cellular bag containing the embryo.

Endocarp, the inner layer of the pericarp next the seed.

Endogenous, applied to the stem, increasing by internal growth and lengthening at the summit.

Endosmose, the transmission of a fluid inwards from without through a membrane.

Endosperm, albumen within the embryo-sac.

Endostome, the little opening (*micropyle*) through the inner coat of an ovule.

Entire, without marginal divisions.

Epicalyx, the outer calyx, formed either of sepals or bracts, as in mallow and potentilla.

Epicarp, the outer layer or covering of the fruit.

Epidermis, the cellular layer covering the external surface of plants.

Epigynous, inserted upon the ovary, applied to stamens and petals.

Epipetalous, inserted upon the petals.

Epiphytal, attached to another plant without becoming organically united with it as a parasite, and growing in the air, as many of the tropical orchids.

Equitant, applied to leaves folded longitudinally, overlapping each other without involution, as in the iris (Lat. *equitare*, 'to ride upon').

Exalbuminous, without a store of albumen: applied to seeds, as the bean and pea, which have an embryo only.

Exogenous, growing from the outside; applied to stems.

Exosmose, the passing outwards of a fluid through a membrane. Compare *Endosmose*.

Exostome, the small opening through the outer coat of an ovule.

Exserted, extending beyond an organ, as stamens beyond the corolla.

Exstipulate, applied to leaves when destitute of leaflets or stipules.

Extine, the outer covering of the pollen-grain.

Extrorse, applied to anthers which dehisce or split on the side farthest removed from the pistil.

Falcate or *falciform*, curved like a scythe.

Fasciculate, leaves growing in tufts, as in pine, larch, &c.

Fibro-vascular tissue, composed of vessels containing spiral and other vessels.

Fibrous, composed of numerous fibres or thread-like substances, as some roots.

Filament, the stalk supporting the anther.

Filiform, like thread.

Fimbriate, fringed at the margin by fine divisions of the lamina (Lat. *fimbriatus*, 'fringed').

Fistular, hollow like the stem of grasses.

Flabelliform, fan-shaped, like the leaves of some palms.

Floral envelope, the calyx and corolla.

Floret, the flower of a composite plant or of a grass.

Flowerless plants. See *Cryptogams*.

Foramen, the opening in the coverings of the ovule.

Free, neither coherent nor adherent.

Free-central placentation, when the placentation or attachment of the ovules to the ovary is axile, but the dissepiments are lost before the ovary is fully grown, so that the ovules are collected in a head in the centre of a 1-celled ovary, as in pinks and stitchworts.

Frond, the leaf of a fern; also applied to the *thallus* or leaf-like expansion of certain cryptogams.

Funicle, the umbilical cord connecting the hilum of the ovule with the placenta.

Furcate, divided into two branches, like a two-pronged fork.

Fusiform, spindle-shaped,

Galbulus, probably meaning a little ball (*globulus*), term applied to the succulent fruit of some of the Coniferæ, as in juniper; the word is used by Varro to denote the fruit of the cypress tree.

Galeate, helmet-shaped.

Gamophyllous, having the leaves united.

Gamosepalous, having the calyx composed of coherent sepals.

Gemmiparous, reproduction by buds.

Gemmule, the first bud of the embryo; same as *Plumule*.

Geniculate, bent like a knee.

Germinal vesicle, a cell contained in the embryo-sac from which the embryo is developed.

Gibbous, having a swelling on some part of the surface (Lat. *gibba*, 'a hump').

Glabrous, smooth, without hairs.

Glands, cells or hairs containing or secreting resinous or oily matter, generally found on the epidermis of plants; applied also to the

lobes of the involúcre of spurge, and to the minute viscid ball at the end of the stalk of the pollinium in orchids.

Glaucous, bluish green.

Glumes, the scaly bracts of grasses and sedges.

Gonidia, green cells in the thallus of lichens which become free and can develope into new lichens; they appear to answer to the buds of higher plants (Gr. *gonē*, 'generation,' and *eidos*, 'resemblance').

Gymnosperms, plants which have naked seeds; not enclosed in an ovary as in conifers.

Gynandrous, applied to stamens adhering to the pistil.

Gynœcium, the female organs of a flower collectively.

Gynophore, a stalk supporting the ovary above the rest of the flower.

Hastate, shaped like a halberd; applied to a leaf with a blade more or less pointed, which has the two parts of its base more or less at right angles to the blade. Distinguish this term from *Sagittate*, which see.

Heart-wood. See *Duramen*.

Herbaceous, plants more or less succulent, and not woody, which die down in winter.

Hermaphrodite, having stamens and pistil in the same flower.

Heterogamous, when the florets of the flower-head in the Compositæ are imperfect, as in the daisy.

Hilum, the point of attachment of a seed or an ovule to the placenta; according to Festus this term is part of the Latin word *nihil*, 'nothing,' i.e. *nehilum*, 'not even the little attachment of a bean,' hence 'nothing.'

Hirsute, having long, stiff hairs.

Hispid, having short, rough hairs.

Homogamous, applied to the florets of a flower-head (*capitulum*) in the Compositæ when they are all perfect, as in the dandelion.

Hybrid, a plant resulting from the fecundation of one species by another, a cross between two species.

Hymenium, usually applied to fungi, denoting that part which bears the spores or sporidia.

Hypocrateriform, shaped like a salver, as the corolla of a primrose, with its long tube and flat limb.

Hypogynous, applied to stamens and petals when they are inserted under the ovary.

Icosandrous, having twenty stamens; applied to flowers in which the stamens are inserted upon the calyx.

Imbricate, overlapping, parts overlying each other like tiles on a house.

Imparipinnate, when a pinnate leaf ends in an odd leaflet.

Imperfect, having stamens only, or pistil only.

Incomplete, when one or more of the whorls (calyx, corolla, stamens, or pistil) is absent.

Incumbent, having the radicle curved over the back of one of the cotyledons.

Indefinite, applied to inflorescence when the principal axis never actually terminates in a flower, but gives off a succession of lateral pedicels; also applied to seeds when numerous, to stamens when more than twenty.

Indehiscent, not opening; applied to fruits which liberate the seed by decay.

Indeterminate, applied to inflorescence. See *Indefinite*.

Indusium, the covering or membrane which at first protects the sori, or little clusters of sporanges, in some ferns.

Inferior, applied to the ovary when it is entirely, or nearly entirely, adherent to the calyx; to the calyx when that organ is free from the ovary; and to the part of a flower farthest from the axis.

Inflorescence, the mode of arrangement of the flowers of plants.

Infundibuliform, funnel-shaped.

Innate, applied to anthers when attached to the top of the filaments.

Innovation, applied to mosses when the leaf-bearing stem continues to grow at its apex by a process of renewal, the older parts dying off behind.

Intercellular spaces, spaces between the cells of the leaf, called also *lacunæ*.

Internode, the space in the stem between two nodes or leaf-buds.

Interpetiolar, between the petioles of opposite leaves; applied to stipules.

Intine, the inner covering of the pollen-grain.

Introrse, applied to anthers which open on the side next to the pistil.

Involucre, a whorl of bracts.

Involute, having the margins rolled inwards: said of leaves in vernation, or of the parts of the flower in æstivation.

Irregular, applied to the corolla when the petals differ in size.

Irritability, applied to the leaves of certain plants, as the *Mimosa pudica*, which fold together when touched; and to the stamens of some flowers, as the common barberry, which, when touched with a needle at the base, suddenly incline towards the pistil.

Juga, applied to the ribs on the fruit of Umbelliferæ.

Jugum, a pair of leaflets: *unijugate*, one pair; *bijugate*, two pairs, &c.

Keel. See *Carina*.

Labiate, lipped; applied to irregular gamopetalous flowers, which are usually two-lipped.

Laciniate, irregularly cut into narrow segments.

Lacuna. See *Intercellular spaces*.

Lamellæ, the gills of an agaric (fungus), as of a mushroom.

Lamina, the blade of a leaf, the broad part of a petal or a sepal.

Lanate, with wool-like hairs.

Lanceolate, narrowly elliptical, tapering to each end.

Latex, a granular fluid, more or less milky, contained in cavities (laticiferous vessels) of certain plants (Lat. *latex*, 'fluid'). See *Cinenchyma*.

Leaflet, applied to a compound leaf when the blade is divided into smaller portions.

Legume, a pod, generally composed of one carpel, which dehisces, or opens, by ventral or dorsal suture.

Lepidote (Gr. *lepis*, a scale), covered with scales or scurf.

Liber, the fibrous inner part of the bark.

Ligneous, applied to stems which are distinctly woody in texture, and do not die down each season, as distinguished from *herbaceous* plants, which see.

Ligule, a little process arising from the petiole of grasses where it joins the blade.

Limb, the blade of a leaf, the broad part of a petal or sepal.

Linear, very narrow leaves in which the length greatly exceeds the breadth.

Lobe, a large division of a leaf or other organ.

Loculicidal, when a capsule dehisces at the dorsal suture of its component carpels.

Loculus, a cavity in an ovary; also applied to the anther.

Locusta, the spikelet of grasses.

Lodicule, a scale at the base of the ovary in grasses.

Lunate, having a form like a half-moon, crescent-shaped.

Lyrate, applied to a pinnatifid leaf having a large terminal lobe, and smaller ones as the petiole is approached, as in the turnip.

Marcescent, withering, but persistent; applied to the corolla when it does not fall off till the part bearing it is perfected.

Medullary rays, narrow, ray-like prolongations of cellular tissue between the fibro-vascular bundles, uniting the pith and the bark.

Medullary sheath, a fibro-vascular layer immediately surrounding the pith, consisting chiefly of spiral vessels and a few woody fibres.

Mericarp, carpel forming one half of the fruit in Umbelliferæ (Gr. *meros*, a part, and *carpos*, fruit).

Micropyle, 'the little gate,' or minute opening in the cellular coat of the ovule.

Midrib, a continuation of the petiole through the middle of a leaf extending to the apex.

Monandrous, possessed of one stamen.

Moniliform, beaded, cells united like a string of beads.

Monochlamydeous, a flower which has a single envelope, viz. the calyx.

Monocotyledonous, having one cotyledon only in the embryo.

Monœcious, having stamens and pistils in different flowers on the same plant.

Monogynous, having one pistil, style, or carpel.

Monopetalous, having the petals united so as to form one petal only; the same as *gamopetalous*.

Monosepalous. See *Gamosepalous*.

Monospermous, having a single seed.

Monstrosity, an abnormal development in any part of a plant, sometimes specially applied to double flowers, or flowers in which the organs of reproduction have been converted into petals.

Morphology, the study of the external forms of the different parts of a plant, and the laws which affect their metamorphoses.

Mucronate, having a *mucro*, i.e. a stiff point, terminating an organ, as the midrib.

Muscology, the study of mosses.

Mycelium, the flocculent network of delicate cellular threads of fungi, generally growing underneath the soil, from which the plants (stem and pileus) are produced; this mycelium imbedded in gardener's mould is popularly known as mushroom 'spawn.'

Mycology, the study of fungi.

Nectary, properly speaking, ought to be restricted to organs containing a sweetish or honey-like fluid, as in the crown imperial; but the term is also applied to glands, lobes of the disk, modified petals, spurs, or other floral appendages, especially if they secrete a fluid.

Node, the knot-like part of the stem from which a leaf-bud proceeds.

Nodulose, applied to roots which have thickened knots at intervals.

Nut, a dry and indehiscent syncarpous fruit, which does not open, but sets free the seed by the decay of the shell.

Obcordate, inversely heart-shaped, i.e. with the segmentation of the heart opposite to the stalk.

Oblique, applied to a non-symmetrical leaf from some inequality between the two sides of the midrib, or from some twist in the petiole, as in the lime.

Oblong, obtuse at each end, about three-fourths as long as broad.

Obovate, reversely ovate, the broad part of the leaf being uppermost. Compare *Ovate*.

Obtuse, not pointed.

Ochrea (from the Latin *ocrea*, 'a legging'), a kind of sheath formed by two stipules around a stem, a membranous stipule, as in the Polygonaceæ.

Operculum, the lid covering the spore-case (*sporange*) of mosses.

Opposite, applied to leaves placed at opposite sides of the stem, face to face; a pair of leaves given off at one node.

Orbicular, applied to a rounded leaf with petiole in the centre.

Orthotropous, ovule with micropyle opposite to the hilum.

Oval, blunt at each end, broadly elliptical.

Ovary, the part of the pistil or female organ which contains the ovules.

Ovate, egg-shaped, applied to a leaf with the broad end next to the petiole.

Ovule, the rudimentary state of the seed contained in the ovary; properly distinguished from the seed, which is a fertilised ovule.

Pale or *palea*, the scale-like body within the glume of the flower of grasses; applied also to the scaly laminæ in the receptacle of some Compositæ.

Palmatifid, applied to simple divided leaves the segments of which radiate from the end of the petiole.

Palmatipartite, when the segments are separated nearly to the petiole.

Panicle, the inflorescence of grasses.

Papilionaceous, bearing a fanciful resemblance to a butterfly (*papilio*): corolla composed of standard (*vexillum*), two wings (*alæ*), and keel (*carina*), as in the pea.

Pappus (Gr. 'an old man,' hence 'grey hairs'), a term applied to the

hairy fruit-achenes of the Compositæ, as of the thistle, dandelion, &c.

Paraphyses, microscopic filaments associated with the *thecæ* (spore-cells) of certain cryptogams, as in fungi and mosses.

Parenchyma (Gr. 'that which is poured in besides'), short cellular tissue.

Parietal, applied to placentation when the ovules are attached to the *wall* of the ovary.

Pectinate, having comb-like teeth.

Pedate, a palmate leaf with the lateral leaflets springing from the branches of a short fork of the petiole.

Pedicel, the stalk of a single flower.

Peduncle, the flower stalk, whether supporting one flower or several.

Peloria (Gr. *pelôr*, a monster), a term applied to those flowers which change from their normal irregular form to one which is abnormal, as in *Linaria*, whose corolla is usually one-spurred, but occasionally five-spurred and regular.

Peltate, spoken of a leaf when the petiole joins the blade upon its under surface, and not at the margin.

Perennial, living and flowering for several years.

Perfoliate, applied to a leaf when the lobes on each side of its base are united together opposite the midrib, so that the stem appears to pass through the blade.

Perianth, the floral envelope; applied in cases where there is only a calyx, or where the calyx and corolla are alike.

Pericarp, the covering of the fruit.

Perigynium, the flask-shaped covering, or loose integument, of the pistil in the genus *Carex*.

Perigynous, inserted round the ovary; applied to stamens and petals.

Perisperm, the albumen or nourishing matter of a seed.

Peristome, applied to the opening of the sporangium of mosses after the removal of the *calyptra* and operculum.

Perithecium, a cavity in some cryptogams containing spores; applied to the closed apothecia of some lichens.

Persistent, not falling off; applied to the floral envelopes which remain attached to the plant after flowering; opposed to *caducous*.

Personate, bilabiate or two-lipped, with the lips closed, as in the corolla of the snapdragon.

Petals, the leaves, generally coloured, which form the whorl of the corolla.

Petiole, the stalk bearing the leaf.

Petiolule, the stalk of a leaflet in a compound leaf.

Phanerogamous and *Phænogamous*, having flowers more or less conspicuous; opposed to *cryptogamic*, which see.

Phyllodes (Gr. 'like leaves') or *Phyllodium*, a petiole dilated in the form of a blade.

Phyllotaxis, the arrangement of the leaves on the axis.

Pileus, the cap-shaped portion of a mushroom or other fungus which bears the hymenium.

Pilose, with rather long, soft hairs.

Pinnate, a compound leaf having leaflets on each side of a central rib.

Pinnatifid, divided in a pinnate manner, with the divisions not reaching to the midrib.

Pinnule, the small branches, or *pinnæ*, of a bipinnate or tripinnate leaf, as the pinnule of the male shield-fern, the middle and lower portions of which bear the fructification.

Pistil, the female organ of the flower, composed of one or more carpels, each carpel having ovary, style, and stigma; from the Latin *pistillum*, a pestle, that from *pinsere*, to pound, in allusion to a common form of that organ.

Pith, the soft cellular tissue in the centre of the stem of a plant.

Placenta, the part of the ovary on which the ovules are inserted.

Placentation, the formation and arrangement of the ovules on the placenta.

Pleurocarpi, mosses whose fructification proceeds laterally from the axils of the leaves. See *Apocarpi*.

Plicate, folded more or less fan-like.

Plumose, having hairs or other appendages arranged on each side of an axis like a feather.

Plumule, applied to the bud of the stem, usually enclosed by the cotyledons.

Pollen (Lat. *pollen*, *pollis*, fine flour), the fertilising dust or powder of the anthers of flowers.

Pollinium, a mass of pollen, as in orchids and asclepiads.

Polygamous, plants having male, female, or hermaphrodite flowers on the same or on distinct plants.

Polygynous, having many carpels or styles.

Polypetalous, having free petals—literally, 'having many petals;' but, as there are usually not more than three, four, or five petals in a flower, and the term is used in contradistinction to *gamopetalous*, having 'united petals,' such a word as *apopetalous* would be more appropriate. The same would apply to the term—

Polysepalous, having free sepals.

Præmorse, applied to a root terminating abruptly, as if 'bitten off.'

Prickles, sharp projections originally from the bark.

Procumbent, lying on the ground, usually applied to stems.

Proliferous, bearing leaf-buds in the place of flower-buds or seeds.

Prosenchyma, long, tapering cells of tissue.

Prothallium, the small, green, leaf-like expansion arising from a germinating spore in ferns and some other cryptogams.

Protoplasm, the matter in cells out of which the plant is nourished and formed.

Pseudo-bulbs, the lower swollen internodes of the stem of epiphytal orchids.

Pubescent, having short, downy hairs.

Pulvinate, cushion-shaped.

Putamen (lit. 'that which is lopped off'—*puto*), applied to the endòcarp, or inner coat or shell or stone, of a fruit.

Raceme, a cluster of short-stalked flowers given off by the peduncle successively; flowers borne on pedicels along a single undivided axis, as in the currant.

Rachis, the axis of an inflorescence.

Radical, applied to leaves which spring from a part near the root.

Radicle, the young root of the embryo.

Ramenta (Lat. 'scrapings'), the brown, thin, scale-like processes on the stems of ferns.

Raphe, that part of the vascular cord connecting the chalaza of an ovule with the placenta, which is adherent to the side of the ovule (Gr. *rhaphe*, 'a seam').

Raphides, minute, needle-like crystals occurring in the tissues of plants (Gr. *rhaphis*, 'a needle').

Receptacle, that part of the flower-bearing stem from which the flower-leaves collectively spring, called also the *floral receptacle.*

Regular, spoken of an organ the parts of which are of similar size and form.

Reniform, kidney-shaped.

Replum, the persistent sutural frame remaining after the fall of the valves in some Cruciferæ (Lat. 'a door-case').

Resupinate, used of flowers when turned upside down, as in the violet.

Retuse, applied to a very obtuse extremity notched in the middle.

Revolute, having the margins rolled backwards.

Rhizome, an underground creeping stem, giving off buds above and roots below.

Rhomboidal, lozenge-shaped.

Ringent, gaping; applied to a labiate flower in which the upper lip is much arched.

Rostellum, a small, knob-like prolongation at the base of the anther in some orchids.

Rotate, applied to a regular gamopetalous corolla with a short tube and spreading limb.

Rotation, a peculiar circulation of the cell-sap, or flowing movement of the protoplasm within the cavity of cells, as in *Chara*, *Nitella*, *Anacharis*, &c.

Rootstock, the same as *rhizome*.

Rugose, wrinkled.

Ruminated, applied to marbled or mottled albumen in some seeds, as in the nutmeg.

Runcinate, applied to a pinnatifid leaf with sharp divisions pointing towards the base, as in the dandelion (from the Latin *runcino*, to plane off).

Runner, a slender running branch, rooting itself and giving off buds, as in the strawberry.

Saccate, bag-shaped; applied to some petals.

Sagittate, arrow-shaped; applied to a simple leaf with a sharp apex and two sharp-pointed lobes projecting downwards. See how distinguished from *hastate*.

Samara, any winged, dry fruit, as the seed of the elm, sycamore, &c.; a word used by Pliny and Columella denoting the seed of some kind of elm—of uncertain derivation.

Sapwood. See *Alburnum*.

Scabrous, rough, covered with stiff, short hairs.

Scalariform, applied to the vessels of ferns, which have ladder-like bars.

Scandent, climbing by means of supports, as on walls or rocks.

Scape, a naked flower-stalk, bearing one or more flowers, which appears to spring directly from the root, as in the tulip (name from Lat. *scapus*, a shaft).

Scarious, like a dry scale.

Scion, the young twig used as a graft; sometimes spelt *Cion* (Lat. *secare*, 'to cut').

Scorpioid, like the tail of a scorpion, curled to one side; applied to the twisted inflorescence of some plants, as the scorpion grass (*Myosotis*).

Secund, turned to or arranged on one side only, as leaves or flowers on

a stalk (Lat. *secundus*, 'following in one direction,' and *sequor*, 'I follow').

Secundine, the second or inner coat of an ovule.

Septate, divided by partitions.

Septicidal, dehiscence of a seed-vessel through the *septa*, or edges of the carpels.

Septum, a partition or division separating the cells of the fruit.

Sericeous, silky, covered with soft hairs.

Serrate, having sharp projections like the teeth of a saw.

Sessile, having no stalk, a leaf without a petiole, sitting, as it were, on the stem.

Seta, a bristle.

Silicula or *silicle*, a short capsule, as that of shepherd's-purse.

Siliqua, a long capsule or pod, as that of the wallflower.

Sinuous, having a wavy margin.

Sinus, the space between segments or lobes.

Sorus, a cluster of sporangia, as in ferns.

Spadix, a fleshy spike of flowers, male and female, usually covered by a *spathe*, as in *Arum*.

Spathe, a large, sheathing bract-leaf, enclosing a *spadix* or flower-spike.

Spawn, applied to the cellular underground network of mushrooms. See *Mycelium*.

Spermatozoids, the minute moving filaments in the *antheridia* of cryptogams.

Spike, inflorescence of numerous flowers sessile on an axis, as in plantain.

Spines (the same as *thorns*), sharp and apparently abortive branches, leaves, or peduncles, originating from the wood, as in the hawthorn.

Sporangium, a case containing spores.

Spores, the cellular, minute bodies in flowerless plants (*cryptogams*) corresponding to the seeds of *phanerogams*.

Sporidiferous, applied to fungi which develope spores in the interior of cells called *asci*.

Sporiferous, applied to fungi whose spores are produced on the exterior of cells called *basidia*.

Standard. See *Vexillum*.

Stipules, leaflets at the base of other leaves.

Stigma, the upper part of the pistil, destitute of an epiderm, which receives the pollen from the anthers (Gr. 'a point').

Stolon, a sucker, a short rooting branch.

Stomata (Gr.), little openings, or 'mouths,' which are found in the epidermis of plants.

Striate, marked with *striæ* or narrow lines.

Strigose, covered with rough hairs.

Strobilus, a cone; spoken of the fruit of firs, and of that of the hop (Gr. *strephein*, 'to twist').

Style, the part between the stigma and the ovary (Gr. *stulos*, a pillar).

Subulate, like a cobbler's awl.

Succulent, fleshy.

Sulcate, furrowed.

Superior, applied to the ovary when free from the calyx-tube, to the radicle of the embryo when straight and directed upwards, to the calyx when the limb of the calyx appears to be inserted on the ovary, owing to the adhesion of the ovary to the tube of the calyx.

Suture, the seam formed by the union of two margins in any part of a plant; that part where the edges of a folded organ unite.

Symmetrical, applied to flowers when the number of parts in each whorl are equal or multiples of each other.

Syncarpous, carpels united so as to form one ovary or pistil.

Syngenesious, when the stamens cohere by their anthers, as in the dandelion, daisy, &c.

Tap-root, applied to a root when it descends deeply into the ground in a tapering manner without dividing.

Terete, when the transverse section is circular.

Terminal, applied to buds which terminate a stem or branch, and which after a winter's rest renew the shoot, as in palms.

Tetragonal, applied to symmetry of organs when the parts are arranged in fours.

Tetramerous, composed of four parts; applied to flowers when the envelopes are in fours.

Thalamus, the receptacle of the flower; that part of the peduncle into which the flower is inserted.

Thallus, a cellular expansion in lichens and other cryptogams (Gr. a young shoot).

Theca, a cell containing spores.

Tomentose, with short, cottony hairs (Lat. *tomentum*).

Torus, same as *thalamus*.

Transpiration, the exhalation of fluids by leaves.

Tricoccus, a syncarpous fruit consisting of three *cocci*, or roundish carpels.

Trifoliate, having three leaflets, as in clover.

Trigonous, three-cornered in cross section, with the angles obtuse.

Trimerous, applied to flowers when the parts are in threes, or multiples of threes.

Triquetrous, having three corners in cross section, with the angles acute ; compare *trigonous*.

Truncate, cut off at the end, terminating abruptly.

Tuber, a thickened underground stem, as a potato.

Tunicated, covered by their external scales, as the bulb of an onion.

Turbinate, in the form of a top.

Umbel, inflorescence in which numerous stalked flowers arise apparently from one point.

Uncinate, hooked.

Unequally pinnate, pinnate with an odd leaflet.

Unilocular, applied to anthers and ovaries having a single cavity.

Unisexual, with stamens only, or with pistil only.

Unsymmetrical, having the parts of each whorl of the flower unequal in number, or not multiples.

Urceolate, urn-shaped.

Valvate, opening by valves, as some seed-vessels, which separate at the edges of the carpels.

Valves, the portions which separate in some dehiscent capsules.

Vascular tissue, composed of spiral and other vessels.

Venation, the arrangement of the veins in the leaves of plants.

Ventral, applied to the part of the carpel which is next to the axis.

Ventricose, inflated, swelling unequally on one side.

Vernation, the arrangement of the leaves in the bud.

Verrucose, covered with wart-like excrescences.

Versatile, applied to an anther which is attached by one part of its back to the filament, hence easily turned about.

Verticillate, arranged in a whorl or ring around a stem or pedicel, in the same plane.

Vexillum, the standard or upper petal of a papilionaceous flower.

Vittæ, cells or tubes containing oil in the pericarp of Umbelliferæ, as in cow-parsnip.

Volva, the wrapper which in some fungi encloses the *pileus* when in a young state.

Whorled, same as *verticillate.*

Wings, the two lateral petals of a papilionaceous flower; the broad, flat edges of any organ.

Zoospore, a moving spore, provided with *cilia*, or hair-like processes.

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HOW TO TEACH ENGLISH LITERATURE.

CHAPTER I.

THE STUDY OF LITERATURE.

It is hardly necessary at this time of day, to enlarge on the pleasures and advantages to be derived from the study of literature. The already considerable, and constantly increasing number of cheap circulating libraries and mechanics' literary institutes in town and country is a sufficient evidence of its growing popularity; showing that many even of the classes supporting themselves by manual labour are glad to devote to *reading* the small margin of time which they can spare for 'self-improvement, and for the cultivation of pleasure in any of its higher and more permanent forms.' Literature belongs to that happy category of good things which are the common property of all civilised men and women—in which the wealth of one is not the poverty of another—which have a powerful tendency to promote sympathy and fellow-feeling among all classes, and go a long way to redress the balance of the unequal gifts of fortune. Nor is it necessary or desirable to attempt to analyse the motives which impel us to the study of literature, or to endeavour to ascertain whether the pleasure of being entertained, or the glow of satisfaction consequent on the acquisition of new knowledge, predominates in the love of reading. In proportion, however, as the latter motive prevails, the pursuit is likely to

be attended with more valuable results, because the books and subjects selected for study will be of a more solid and permanently interesting character. But even what is called 'light reading,' if only it be manly and pure in tone, and of acknowledged ability in composition, may be most valuable and important as an instrument of culture. There are standard works of fiction, from *Alice in Wonderland* back to *Gulliver's Travels*, which no one pretending to literary culture can venture to be ignorant of; and some, at least, issue every year from the press, instructive and improving from their vivid descriptions of scenery, subtle analysis of character, polished language and cultivated tone; and indirectly conveying valuable information on social questions and the like, which the humbler classes could hardly get at in any other way.

Our own literature may well be described, in the language of Macaulay, as 'the most splendid and the most durable of the many glories of England.' No other country possesses a literature so rich, so varied, and so continuous. Among the nations of antiquity, the literature of the Romans is worthless in its earlier stages, borrowed and imitative in its later. Among the moderns, German literature lay dead from the middle of the sixteenth to the middle of the eighteenth century. The seventeenth saw the last efforts of Spanish literature. From about the same period, till within living memory, Italy had given birth to no writer of the first rank. Of England and France only, among existing, and of Greece, among ancient civilisations, it can be said that during the whole of their mature existence 'they thought and wrote,' producing an unbroken series of monuments of literary genius. But the extant literature of Greece consists mainly of scraps and fragments, and those belonging to a dead world. The literature of France is indeed unbroken, copious, inventive, brilliant and graceful, a worthy representative and expression of the versatile genius of her

gifted people; but many not unimportant departments might be named, in which the literature of France can hardly be said to stand on a level with that of England.

The English language.—The language in which our books are written is of a very complex and composite kind—of infinite variety both as to origin and subsequent modifications—the result of a long series of historical events, combinations, accidents, as we call them—all of which belong rather to the subject of Language than to that of this Manual. The English language is, however, pretty generally admitted to be, upon the whole, the most perfect living instrument for the expression of thought and emotion, 'less musical, indeed, than the languages of the South; but, in force, in richness, in aptitude for all the highest purposes of the poet, the philosopher and the orator, inferior to the tongue of Greece alone.'

The aim of the teacher of English literature to the scholars of elementary schools should be *to give his pupils a love for literature*:—such a love, that is, for the study, and such an intelligent comprehension of the way to set about it, as may induce them to prosecute it for themselves in after life. This object must, under the conditions of the case, be attempted by making them acquainted with some one or more of the most attractive and beautiful productions of English authors; acquainted, not smatteringly, but thoroughly, (1) by securing that the passage shall be carefully learned by heart, and its sense, allusions, and constructions thoroughly mastered; and (2) by pointing out to the learner the qualities and characteristics which constitute the superiority and charm of the writer. With such an object before him, the teacher will especially direct the pupil's attention as he advances in intelligence, to such points as these:—

First (generally), the author's selection of a *subject* capable

of interesting and original treatment, and adapted to his own genius and acquirements.

Second, the reasons which seem to have dictated the choice of one *word* rather than another, the pathos of this expression, the fire of that, the incisiveness of another—the happy antithesis, the well-fitting illustration, the pointed allusion, the subtle aroma of classical culture, the balance of the sentences, the march and roll of the paragraph gathering strength and intensity as it approaches its close.

How to teach literature.—It is no easy matter to give advice under the above head, which shall be at once *practical*, with a view to obtaining 'results' with the least possible expenditure of time and trouble—and at the same time *not misleading* to those teachers who have higher and more far-seeing aims than those of 'satisfying' an examiner. For 'practical' purposes, the task before the teacher is to secure that his pupil-teachers, or, if he 'takes up literature,' his class scholars of a certain standing—shall be able *to repeat accurately and to understand* a specified portion of poetry or prose, selected by himself, but requiring to be 'approved by H. M.'s Inspector.' Nothing short of this will (or ought to) secure a 'pass.' But a teacher will have done but half his duty in the matter, unless, in addition to this, he has tried his best to bring the mind of the scholar to understand the spirit, as well as the letter, of the passage which is being committed to memory. And he has, moreover (in the judgment of the writer of this manual), done but three-quarters of his duty, if, in addition to all this, he has not endeavoured, at least in the case of his pupil-teachers and more advanced standard children—to give them some idea of the author's 'antecedents,' the influences under which he wrote, the characteristics of his style, and the age and stage of development of English literature to which he belongs.

The teacher will probably find it a hopeless task to attempt to get into the mind of the class scholar—or even of

the pupil-teacher, during the short time that can be spared from other subjects—anything like a complete chronological and historical view of English literature in connection with the successive developments of the language, and with contemporary events. The acquisition of such knowledge will probably have to be deferred to a later period in the student's life, when he may be able to snatch some leisure from the peremptory claims of breadwinning work, to cultivate at least one subject which has become his favourite amongst the many to which he was introduced at school or training college. Indeed, if a teacher were to *begin* by trying to give a pupil a systematic chronological account of English literature, he would be acting contrary to sound policy, for he would be putting forward first that which is perhaps to youthful minds the least attractive aspect of the study. In a case of this kind, where pleasure is, if possible, to be made the handmaid to intellectual exertion, *systematising* must come last;—at a period when the mind, having already accumulated some literary treasures, and come to admire and love certain productions of literary genius, feels a craving to set them in order, as it were, in a chronological framework, and understand how and when they came to be what they are. This manual, however, is intended for *teachers*. For your own use, therefore, as a teacher, to guide you in your selections, and to guard you against anachronisms in explaining allusions and the history of words in your teaching, it is highly desirable that you should have clearly fixed in your mind at least a rough sketch, if it be a mere skeleton, of the history of the growth and developments of English literature.

CHAPTER II.

HISTORICAL SKETCH.

IF the landing of the first Teutonic invaders in Britain be taken as the birthday of the English nation, that nation is now something over 1400 years of age; but for the first 400 and more of those years it had not come into possession of a literature, or even of a common national language of its own. If we except the laws of Æthelred, the first Christian King of Britain (A.D. 596), and a few ballads and songs of uncertain date,—*the poem of Cædmon* (A.D. 680, see below) was England's sole literary inheritance from the 400 years of struggle and anarchy which had elapsed between the first settlement of Jutes in Kent, and the Peace of Wedmore (A.D. 878), at which the Danes acknowledged the supremacy of the great King Alfred. He it was who laid the first humble foundation of English letters, and, by collecting and arranging the fragments which existed, by translations, or by the impulse of his own example and original compositions, created the earliest specimens of the 'mighty roll of books' which now fills our English libraries. But still, and for centuries to come, the claims of England to the possession of a literature are slender enough, and rest chiefly on the existence of the *Anglo-Saxon Chronicle*. This chronicle, which may be said to date from Alfred's reign (for he supplemented its previously meagre outlines from the Latin history of Bæda, and threw it into its present form), runs unbroken for 300 years, through Danish and Norman conquests, into the middle of the

Semi-Saxon period. It breaks off abruptly at the death of King Stephen; but this was only 50 years before the appearance of the *Brut* and the *Ormulum* (of which more presently), and only 100 years before the great literary epoch of Chaucer and Wickliffe.

Most teachers are already familiar, from their studies in the English Language and Grammar, with the origin, and ordinarily adopted chronological stages of the language, as they are to be found in most of the text books in use. It may be well, however, to have them drawn out briefly in the following table, for the sake of reference, if necessary, as we go along :—

(1) The **Anglo-Saxon** period (A.D. 450), lasting for some 600 years, till

(2) The **Semi-Saxon** period (A.D. 1066), lasting for some 150 years, till

(3) The **Early English** period (A.D. 1200), lasting for some 150 years, till

(4) The **Middle English** period (A.D. 1350), lasting for some 100 years, till

(5) The **Modern English** period (A.D. 1450), lasting to the present time.

During the first **three** of these periods—that is, up to the middle of the fourteenth century—the native literature of England, though written in the mother tongue of our present English, is intelligible to the student only with the help of grammar and dictionary, like a foreign language. Information on the subject of such literature does not of course come within the limits of this Manual; the following examples, however, of the literature of each period will serve to give some notion of the progress of the language to a stage of partial intelligibility by readers acquainted only with Modern English.

The first is from Cædmon (pronounced Kaydmon, not Seedmon), who wrote a sort of early *Paradise Lost and Regained*, about A.D. 670.

(1) Satan says after his fall :—

þæt me is sorga mæst	This to me is of sorrows greatest
þæt Adam sceal	that Adam shall
þe wæs of eorðan geworht	(who was of earth wrought)
minne stronglican	my strong
stol behealdan,	habitation possess;
wesan him on wynne	that **he** should be in happiness,
and we þis wite þolian	and **we** this torment endure (*thole*)
hearm on þisse helle.'	misery in this hell.

(2) Alfred (878).

For þi me þincð betere gif eow swa þincð þæt we eac sume
Wherefore me thinks better if you so think, that we also some

béc þa þe niedbeþyrfyste syn eallum mannum to witanne
books, those which most-needful are to-all men to understand

þæt we þa on þæt geþeode wendon þe we ealle ge-cnawan mægen
that we them into that language turn which we all know can,

and gedon swa we swiðe eaðe magon mid Godes fultume þæt eall seo
and cause, as we very easily can, with God's help, that all the

geoguð þe nu is on Angel-cynne freora manna þara þe þa
youth that now is in England, of-free men of-those that the

speda hæbben þæt hi þam befeolan mægen syn to leornunge
wealth have that they to them attend can, be unto learning

oðfaeste.
put.

N.B.—The above belong to the pure Anglo-Saxon period: for specimens of Semi-Saxon and Early English, see below.

Your pupils will, perhaps, be somewhat incredulous on being told that these uncouth-looking fragments were written in the mother tongue of the language which they speak every day. Its unfamiliar look is increased by the presence of two letters which have dropped out of our alphabet, þ and ð, both of which, according to the best authorities, stand for the hard sound of 'th' (= dh) as in 'then' and 'there.' The diphthong 'æ' (which occurs so frequently) is only a softer and weaker form of the letter 'a.'

During the 200 years which followed the cessation of the *A.-S. Chronicle* in 1154, three works only attest the survival, and keep up the continuity of our literature, viz. :—

(1) *The Brut* of Layamon (circ. 1200), a poem of 30,000

lines and more, relating the world-famous story of Brut, the great-grandson of Æneas; how he landed in Britain, and founded a dominion lasting, through King Arthur of the Round Table, to Cadwallo, the hero of Wales in the seventh century.

(2) *The Ormulum* of Ormin (circ. 1280), a metrical harmony of the Gospels and daily service-book, in 10,000 fourteen and fifteen syllable verses.

(3) *The Riming Chronicle* of Robert of Gloucester (1298).

The Brut.—Semi-Saxon period.

—Layamon gon liðen	—Layamon travelled
wide yond þas leode	Wide thro' the people
and bewon þa aðele bóc	And won the noble book
þa he to bisne nom.	That he for (his) model took.
He nom þa Englisca bóc	He took the English book,
þa makede Seint Bæda,	Which St. Bæda made;
anoþer he nom on Latin	Another he took in Latin,
þe makede Seinte Albin	Which was made by St. Albin,
and þe feire Austin	And the fair Austin,
þe fulluh broute hider in.	Who baptism brought in hither.

N.B.—This is the latest extant work which can be called Anglo-Saxon.

The Ormulum.—Early English period.

I hafe sette here o (*in*) thiss bóc amang Godspelles wordes, alle thruh meselfen (*all by myself*) manigword (*many a word*) the rimė swa to fillen (*so to complete*). Ac (*but*) thu shal finden that minn word eggwhær thær (*everywhere where*) it is ekedd (*added*, see 'eác' = 'eke' = 'also,' in the extract from Alfred, above) magg (*may*) helpen tha (*those*) thatt reden it to sen (see) and tunderstanden.

The Riming Chronicle.—Early English period.

Ich wene ther ne beth in al the world countreyes none,
That ne holdeth to her kunde speche but Engelonde one.
Ac well me wot for to conne both wel yt ys;
Vor the more that a man con the more worth he ys.

I ween there be not in all the world any countries that hold not to their natural speech, but England only. But well I wot that well it is for to know both (*French and English*); for the more that a man knows the more he is worth.

CHAPTER III

MIDDLE ENGLISH PERIOD.

THE middle of the fourteenth century marks the commencement of a new and important epoch, an epoch in which English prose and poetry emerged from a tolerated, and almost a precarious, existence into the position of a National Literature. At about the date when English was for the first time employed in Courts of Law (1362), **Sir John Mandeville** returned from thirty years' travelling over a great part of the then known or accessible world, and wrote an account of much that he saw, and much that he certainly never could have seen, first in Latin, then in French, and lastly in English, 'that every man of my nation,' says he, 'might understonde them.' To read Mandeville is no very difficult task to a modern Englishman; but romance, and somewhat silly romance too, is so mixed up with reality in his work, that it is interesting and valuable chiefly as a literary curiosity, and for the light which it throws on the progress of literary language. It is the first work, if we except the defunct *Anglo-Saxon Chronicle*, which can be said to be written in National English—those named previously having been composed in rustic and local dialects. Here is a specimen from Sir John Mandeville's Travels:—

Gatholambes (Prince of the Assassins) was full of cauteles and of subtile deceits; and he had a full faire castel and strong in a mountain. And within, the fairest garden that any man might behold, and therein were trees bearing all manner of fruits. And there were in that place many a divers things, and many divers stories, and of beasts and of birds that sungen full delectably, and moveden by craft, that it seemed that they weren quick; and he had also let make three wells, fair and

noble, and all environned with jasper, stone of chrystal, diapered with gold and set with precious stones and great Orient pearls. And he had made a conduit under earth, so the three wells, at his list, one should run Milk, another Wine, and another Honey. And that place he cleped Paradise.

Sir John Mandeville was a physician and man of culture, and his language is far more easily understandable by a modern English reader than that of the author of the famous *Vision of Piers Plowman*, written at about the same date as Sir John's itinerary. The *Vision* is altogether unsuitable to be proposed for scholars or pupil teachers to commit to memory; and indeed the rudeness, uncouthness, and unfamiliarity of the language, the absence of rhyme, and the somewhat stern and gloomy earnestness of the writer, deprive it, though full of noble and elevating thoughts, of much of the charm it might possess for youthful minds. The *Vision* was enthusiastically received by the people, delighted at seeing a poem in their own language taking rank with, and gradually superseding the French and Latin writings, which had hitherto had it all their own way in England. Here are the opening verses of the *Vision* :—

In a somer season . when softe was the sonnè
I shope me in shroudès . as I a shepe weerè,
In habite as an heremite . unholy of workès
Went wide into the world . wondèrès to herè
Ac on a May morwenyngè . on Maluerne hullès
Me byfel a ferly . of fairye me thoughtè
I was wery forwandred . and went me to restè
Under a brode bankè . bi a bornès sidè
And as I lay and lenèd . and lokèd in the watèrès,
I slombrèd in a slepying . it swyuèd so mery.

This is fairly intelligible, with a few hints. (1) As for the *spelling*, it was capricious enough, and then and for a long time afterwards his spelling was part of a writer's *style*. *I* and *y* are arbitrarily interchangeable (see below, page 19, '*It*'). (2) The *metre* consists of two half lines each of six syllables, and the mark of separation may be considered equivalent to a comma. The final *e* is always sounded syllabically at the end of lines, and indeed at the end of words also, whenever

not used merely to lengthen the preceding vowel. The accents on the terminations in the passage above show where they are to be sounded as syllables. Rhyme (which we saw employed half a century earlier by Robert of Gloucester) is now altogether discarded, but instead of this gratification and assistance to the ear, *alliteration* is used. That is to say, two (or more) syllables (the 'loud' or emphatic syllables) in the first half line, and one of those in the second distich, commence with the same consonantal sound, as marked above by thick black initial letters. In the first line 'sonne,' in the fourth 'went,' in the eighth 'bi,' and in the last 'so,' give a superfluous alliteration. 'Shope' is an old form of the past tense from *shape*, and means, I shaped or arrayed myself. 'Shroudes' and 'weeds' were words formerly employed for attire generally, and not restricted to the melancholy habiliments they are now used to designate. 'Shepe' is the shepherd, and not, as we might imagine, his fleecy charge. Un*H*oly shows two things: first, that the alliteration is not verbal but syllabic; and, secondly, that the author's general opinion of hermits is, as appears abundantly elsewhere, unfavourable. 'Ferly' is a wonder (fear). 'Of Fairy,' = by fairy agency. 'Forwandred' is tired out with wandering. To 'swyued'—sounded ('soneded' in some manuscripts)—we have no nearer surviving relative than 'sough.'

Whether out of the wide range of English literature, poetry of this sort should be selected for your pupils to commit to memory is a question which would probably be decided in the negative if referred to authority; but the *Vision of Piers Plowman* is a noble poem in tone and substance, and by no means so unmelodious, if properly recited, as it might at first appear.

The same question would probably be decided in the same way in the case of the almost contemporaneous work, the *Canterbury Tales* of CHAUCER, which is beyond question the greatest English poem before the Elizabethan age. Nothing could be in stronger contrast than the two works

and the two authors. **William Langland**, the supposed writer of the *Vision*, is evidently himself one of the people, full of their wrongs and aspirations, brought up in the midst of rural sights and sounds, and his poem throughout breathes all the bracing freshness of the air of the 'Malverne Hulles' of which he speaks so fondly. Chaucer was a courtier and man of the world, who had experience of almost every vicissitude of fortune and every phase of the social life of his day. His great poem ranges over the whole area of humanity—full of contrasts, grave and gay, satirical and pathetic, political, religious, and, too frequently, coarse and licentious, but always full of point, life, and colour. Take, for example, the famous passage in which he describes the ideal parish priest of his day :—

> A good man was ther of religioun,
> And was a pourè PERSOUN of a toun ;
> But riche he was of holy thought and werk.
> He was alsò a learnèd man—a clerk
> That Cristes Gospel trewly woldè prechè ;
> His parisschens devoutly wolde he techè.
> Wyd was his parische and houses fer asonder,
> But he ne lafte not (*did not leave off*) for reyne ne thonder,
> In sicknesse nor in meschief (*misfortune*) to visitè (*visiteth*)
> The ferreste (*farthest*) in his parissche, moche and litè (*great and small*) ;
> And though he holy were, and vertuous,
> He was to sinful man nought despitous.
> To drawè folk to heven by fairnèssè,
> By good ensample, this was his busynèssè.
> He waytede for no pompe ne reverence ;
> Ne makèd him a spicèd (*over-scrupulous*) conscience,
> But Cristès lore, and His apostles twelve
> He taughte, but first he folwede it himselve.

The description from which the above passage is taken, by an earnest seriousness of tone which is not common in the *Canterbury Tales*, serves as a point of connection between Chaucer and his great contemporary JOHN WICLIF, who about this time began the great work of his life—the emancipation of his countrymen from the spiritual tyranny of Rome. Though his original contributions to literature

seem small in bulk compared with those of Chaucer, and though they are confined to controversial theology, he did more for the development of the English language than his brilliant contemporary; because writing, as he did, for the people, he discarded the use of French words and idioms, and, forging the implements he worked with as he went along, sought to make the language spoken by the mass of his countrymen a sufficient vehicle of thought for his purpose.

Latin was up to this time the language of learned literature. The most important works, from the history of Bæda downwards, were written in Latin, and even political songs were composed in that language. French had been even as early as the time of the English Edward the Confessor (1050) the language of the Court and the nobility. William the Conqueror was the only Norman king who attempted (and he vainly) to learn English; and of the French dynasty that succeeded his sons on the English throne, it is doubtful whether more than one could speak or write English with ease and correctness. Wiclif announced his aim to be 'to teach simple men and women the way to heaven,' and he writes thus in his introduction to the New Testament:—

> Cristen men and wymmen olde and yonge shulden studie fast in the Newe Testament, for it is of ful autorite and opyn to undirstonding of simple men as to the poyntis that be most nedeful to salvacioun. Therfor no simple man of wit be aferd unmeasurabli to studie in the text of Holy Writ, and no clerk be proude of the verrey undirstondyng of it, for whi undirstondyng of Hooly Writ withouten charite that kepith Goddis heestis, makyth a man depper dampned.

Nor when speaking of the English prose writers of the age ought 'Canon' Trevisa, of Westbury, to be altogether passed over, though he is best known as a translator. The following passage from his version of Higden's *Polycronycon* (1387) is interesting, more than for any literary merit it may possess, on account of the light which it throws on the history of the language at this important transition period:—

> For 200 years children in scole, agenst the usage and manir of all other nations, beeth compelled for to leve hire own language, and for

to constru hir lessons and hire thynges in Frensche. Gentilmen children beeth taught to speke Frensche from the tyme they bith rocked in hire cradell, and uplondissche men will likne himself to gentylmen, and fondeth with great busynesse to speke Frensche.

Speaking in his own name, *twenty years later*, Trevisa says, commenting on this passage:—

Now in all the Gramer Scoles children leveth Frensche and lerneth on Englyshe.

Notwithstanding the hopeful condition and prospects of the language thus described, the century which followed the date of these authors—the remainder of the Middle English period—was barren and unproductive in literature. The monk **Lydgate**, who imitated Chaucer, and wrote about the time of his death, serves as a link to connect that poet and his contemporaries with the first **modern** English poet, **Thomas Howard, Earl of Surrey,** in the reign of Henry VIII. (see below, page 21).

It is not a little remarkable that some of the most easily intelligible, and quasi-modern poetry of the Middle English period should have come from the pen of a Scotch archdeacon, writing in what was evidently the current language of the Lowlands in his day. His subject is *The Bruce*, but his historical authority does not stand very high. Among other slips, though writing within twenty years of the king's death, he makes King Robert identical with his own grandfather. Some fifty years later another Scotchman, no less a personage than **James I.** of Scotland, took advantage of a long imprisonment in England to learn English. But for his retention of the syllabic *e* final, and *is* for the plural form, he might be said to belong to the modern period; and there is nothing in our language till we come to Spenser, so pure and tender as the verse in which he relates his happy courtship of the Lady Jane Beaufort, who afterwards became his wife. Here are some of his verses:—

From *The King's Quhair* (*quire, or book.*)

Now was there made, fast by the touris (*tower's*) wall
A garden fair, and in the corners set
An herbere (*arbour*) green, with wandis long and small
Railèd about, and so with treïs set
Was all the place, and hawthorn hedges knet,
That lyf (*living creature*) was nonè, walking there forby
That might within scarce any wight espy.

Archdeacon Barbour's English is a little more rude and difficult.

A! Fredome is a nobil thing!
Fredome mayse man to haiff liking!
Fredome all solace to man giffs,
He levys at ese that frely levys (*lives*).
A noble hart may haiff nane ese
Na ellys nocht (*nor (n)aught else*) that may him plese
Gyff Fredome failythe.

CHAPTER IV.

AGE OF FIRST PRINTED BOOKS.

The works of the writers above quoted, though possessing the deepest interest from a literary and historical point of view—having been composed before the English language had settled down into the form now in use, cannot of course be studied as models for modern compositions, and it would be absurd affectation on our part to attempt to imitate, or form a style upon them. Moreover the language up to this time differs, more or less, from modern English in structure and in grammar, and is therefore not so well adapted for study and exercises in analysis, parsing, and syntax, with which it is desirable to combine the exercises in recitation.

Age of first printed Books.—About the middle of the fifteenth century, however, a second remarkable step in advance is marked by the appearance of the works of Sir John Fortescue, Chief Justice of the King's Bench under Henry VI., the first of our writers who can be called *modern.* Anyone who carefully studies the following passage from his works will see that the language which he employs differs from modern English chiefly, if not solely, in its orthography, and is practically the same in structure, grammar, and all other essential characteristics. As for the orthography, the only standard of spelling seems to have been the taste of the writer, and so it continued for centuries. Tyndal, in his version of the New Testament, spells the pronoun 'it' with a *y* and an *i* indifferently and in eight different ways; and, indeed, it was not till the days of Dr. Samuel Johnson that any systematic attempt at uniformity in spelling was made.

Fortescue writes as follows in his treatise entitled, *Of the Praises of the Laws of England*:—

Every inhabiter of the realme of England useth and enjoyeth at his pleasure all the fruites that his land and cattel beareth, with al the profits and commodities which, by his owne travayle, or by the labour of others, he gaineth; not hindered by the injurie or wrong deteinment of anye man, but that hee shall be allowed a reasonable recompence. They drink no water unlesse it be so that some for devotion, and uppon a zeale of penaunce doe abstain from other drinks. They eate plentifully of all kindes of fleshe and fishe. They weare fine woollen cloth in all their apparel; they have also abundance of bedcoveringes in their houses, and of all other woollen stuffe. They have greate store of . . . all things that are requisite to the accomplishment of a quiet and wealthy life, according to their estates and degrees.

With Sir John Fortescue we may couple the name of **Sir Thomas More** as belonging to this period, though he lived some sixty years later, because it is a moot point with literary authorities which of the two is to be called the first writer of *modern* prose. Here you have an opportunity of judging for yourself. (Sir T. More's *History of Edward V. and Richard III.*, 1510):—

Richarde the 3rd Sonne, of whom we now entreate, was in wit and corage eqall with either of them; in bodye and prowesse farre under them bothe, little of stature, ill-fetured of limmes, croke-backed, hard favoured of visage. He was malicious, wrathfull, envious, and from afore his birth ever frowarde.

N.B.—Sir T. More's more celebrated work, the *Utopia*, was not composed in English.

About half-way between these two authors stands WILLIAM CAXTON, who introduced the art of printing into England from Germany, and published the first book printed in England in 1474. This is, indeed, a memorable event in the history of literature and of civilisation. It is curious to observe, however, that the language of Caxton, though written twenty-five or thirty years later, is far more antiquated than that of Fortescue. Here is a passage from his preface to the translation of the *Æneid* (1480):—

The booke is named Eneydos, made by that noble poete and grete clerke Vyrgyl, which booke I saw over and redde therein: Howe after the generall destruction of the grete Troy, Eneas departed, berynge his

old fader Anchises, upon his shoulders, his lytyl son, Youlas, on his hande, his wife, with moche oder people followynge; and howe he shipped and departed, wyth alle the storie of his adventures that he had ere he cam to the atchievement of his conquest of Ytalie. Which booke, as me seemed, shold be moche requysite to noble men to see, as well for the eloquence as for the hystories.

With the name of Caxton will always be associated that of **Sir Thomas Malory,** whose famous *Morte d'Arthur*, the source of Tennyson's *Idylls of the King*, was among the books first printed by him (1485).

Contemporary with Sir J. Fortescue was **Bishop Pecock,** whose works are a fine specimen of theological prose: a passing mention should also, perhaps, be made of Bishop Latimer's homely and persuasive sermons. The **poetry** of the period consists of a host of ballads, some of them full of charm and sweetness, by nameless authors. The majority of these cluster round the traditions of Robin Hood, the mythical hero and darling of the country people, with whose adventures Sloth, in *Piers Plowman's Vision*, is well acquainted, though he has 'forgotten his paternoster.'

Sir T. Wyatt and **Lord Surrey,** in poetry, and **Roger Ascham** in prose, though they wrote in this age, belong properly, in respect both of matter and manner, to the Elizabethan period, on the threshold of which they stand. Wyatt and Surrey were both Italian travellers, and the first to introduce into England the literature of that country, which exercised such a strong influence on the drama and the poetry of the next generation.

Progress of the language.—We have seen that the transition stage of our language may be roughly said to last from the coming of the Normans to the middle of the reign of Henry VI. (1066 to 1450). *Up to* the former date, good Anglo-Saxon was written and spoken; *after* the latter, good Modern English. The foregoing sketch of Early English literature would, perhaps, be incomplete without some attempt to explain the process by which this great change was brought about in the intermediate period. The degradation

of the language from the Anglo-Saxon to what is called the Semi- (or broken) Saxon, though following closely in time upon the Norman Conquest, must not be attributed altogether, as it sometimes is, to the degradation of the Anglo-Saxon element *in the nation* which was the consequence of that event, or to an overwhelming influx of French words and idioms. The changes brought about by the introduction of French belong to a date three centuries later in the history of the English tongue. Indeed, French had been the language of the Court and of fashion for some time *before* the Conquest, and good Anglo-Saxon was *written* for the best part of a century *after* that event. It was not as a literary, but as a *spoken* language that Anglo-Saxon deteriorated, literature having, of course, a strongly conservative effect upon language. But the fact is that, at certain stages, all languages have a tendency to become less *inflexional*, and to substitute particles for changes in the form of the original stem word. This process was, no doubt, accelerated at the time of which we are speaking, by a fact to which the English tongue owes its survival through the period of rigorous Norman ascendency—namely, by its continued use as a spoken tongue among the people. Though the *Anglo-Saxon Chronicle* was continued in good Anglo-Saxon for fifty years after the Conquest, and in language of scarcely deteriorated purity for fifty more, wide gaps follow in the continuity of the use of the Anglo-Saxon tongue as a *literary* language, and it came to be remoulded by slow degrees in the mouth of the common people; so much so, that when it re-appears as a literary language (1200), the disintegration which had taken place in the interval is clearly marked. (Compare extract from the *Brut* with the pure Anglo-Saxon of the two extracts immediately preceding it on page 10).

During the Early and Middle English periods the same process went on, exhibiting itself in a gradual softening down of the old grammatical inflexions; which, if it had been

allowed to proceed, would have at length ended in producing a form of speech as nearly as possible *analytical*—a form of speech, that is, in which particles take the place of inflexions. Clearly, therefore, some powerful influences must have been at work to check the progress of the language towards perfect *analysis*. Now attention has already been called to the conservative tendencies of *literature*; and the arrest of the progress of disintegration is doubtless due in great measure to the outburst of literary activity in the latter half of the fourteenth century. However, the influence of literature alone is insufficient to account for this arrest, since 'it failed to preserve the verbal and case endings of Chaucer and his contemporaries for a single generation.' But a more powerful conservative influence was now, for the first time, brought to bear upon the language. PRINTING had been invented in Germany about the year 1440. Some thirty years later Caxton issued the first printed English book, *The Game and Play of the Chesse*—and nothing has done so much for preserving the existing forms of language as the introduction and rapid extension of this wonderful art. From that time our language has sustained no further loss. Whatever grammar the language, strictly speaking, then possessed, it still possesses; the changes since then observable being only such as all spoken speech must be liable to, and being chiefly concerned with such matters as style, idiom and expression, and, of course, orthography. While the grammar and structure of the language were undergoing the process above described, radical changes in the direction of augmentation, had taken place in the *vocabulary*. In the long struggle between French and English during the Middle period, the victory lay with the English language. Now this is to be attributed not so much to the vitality of the latter tongue, as to the fact that, owing to the fusion of the two races in the thirteenth century, the Anglo-Normans began to cultivate English, and to substitute it for French in their writings when English came to be universally spoken by all classes.

Writing thus in English, with a limited knowledge of the vocabulary of that language, they were forced to fall back upon Norman-French words, or borrow from some other *Romance* language which they happened to be acquainted with. This perhaps chiefly accounts for the presence of the great proportion of words derived from foreign sources which we find, for example, in the *Canterbury Tales*, and even in the *Vision* of rustic stay-at-home Langland, who, in a less degree, fell in with the tendencies of his age.

CHAPTER V.

THE ELIZABETHAN AGE.

Revival of Learning.—We left off with Sir T. More in the year 1510. It would carry us too far afield to enter upon the causes of the great revival of learning which took place in England in the sixteenth century. It showed itself chiefly of course in the impulse given to **classical study,** but it was the cause of a marvellous awakening of men's minds to activity in every part of the literary field. It is not a little remarkable that the two most striking steps in advance made by English literature should have followed, the first shortly after the commencement of the political emancipation, and the second shortly after that of the religious emancipation of the people.

A large portion of this introduction has been devoted to our ancient literature, because to teach literature in any satisfactory sense implies a knowledge on the part of the teacher of the stages by which it came into its present condition. Hitherto we have had to deal with comparatively simple materials; a poem or two in one century, annals extending over three, works which had single and exclusive possession of men's minds for years at a time. The rest of this sketch must be devoted to comparing the claims of cotemporary writers, pointing out the peculiarities of a few of the most famous types of each stage of development, and endeavouring, if possible, to show in what characteristics one century (of the three which have elapsed since the

revival of learning in the fifteenth) may be said to differ from another.

The Elizabethan age.—Those who wish for an explanation or a theory of the marvellous outburst of literary activity and genius in the age of Elizabeth, should consult M. Taine's lectures, or Mr. Green's delightful literary chapters; but all students should be made to understand that it was not such a sudden outburst after all, as it is sometimes represented to have been. During the previous half-century, though few great works were produced, new experiments had been tried in the art of writing, new veins of thought had been opened, and new elements introduced into literature, which appeared to bear fruit all at once when the time had come. Everywhere men's minds were astir; a new world had been discovered, English sailors had circumnavigated the globe, and brought home accounts stranger than fiction, of hitherto unknown lands beyond the sea. The religious consciousness of the nation had been rekindled; learning had revived, and the study of the classics had become, for the first time, part of the literary life of England; Wyatt and Surrey had introduced the masterpieces of Italian literature; and last, but not least important, printing had been invented, to disseminate and to perpetuate the productions of literary genius.

The Elizabethan drama.—Five great dramatists were during this period represented on the English stage, from poor unhappy **Greene** and **Marlow,** who killed themselves by debauchery, down to gentle **Shirley,** with whom the Elizabethan drama dies in 1666. At their head, of course, stands WILLIAM SHAKESPEARE, the greatest dramatist, and, if the drama be the highest form of poetry, the greatest poet, of all time. His first original play, *Love's Labour's Lost*, appeared in 1592, and for one and twenty years 'he made the drama represent the whole of human

life,' till his work ended with the play of *Henry VIII.* in 1613. The other great names of the period in dramatic literature are **Ben Jonson,** the author of *Every Man in his Humour,* almost cotemporary with Shakespeare, and possessing kindred power, though standing far below. With **Beaumont** and **Fletcher, Massinger** and **Ford,** powerful as they were, began the decay of the English Drama, because, forsaking the 'modesty of nature,' they strove to excite the passions of their audiences at any cost, by representing humanity under sensational and unnatural conditions.

Imaginative poetry, which had been first awakened by Cædmon, and reawakened by Chaucer, only to sink into deeper death after him, is represented in this great Revival by EDMUND SPENSER, the author of the *Faerie Queen,* 'the first great ideal poem that England has produced, and the source of all our modern poetry.'

Criticism, which occupies so prominent a place in modern literature, may be said to have begun with *The Art of Poetrie,* by **Sir Philip Sidney** (better known as the author of *The Arcadia*), the ideal knight of these latest days of chivalry.

Theology, Philosophy, and **History,** are represented by RICHARD HOOKER'S great work, the *Ecclesiastical Polity* —a model of grand and grave English prose, LORD BACON'S *Essays,* and **Sir Walter Raleigh's** *History of the World.*

The age of Elizabethan literature, taken in its most extended sense, goes down to the middle of the seventeenth century. Its best characteristics were, the love of truth, and beauty in all its forms, straightforwardness and manly simplicity of feeling and expression; genuine passion, force and originality, combined, in its best representatives, with consummate literary art. The Elizabethan age was followed, like the age of Chaucer, by a period of eclipse. Poetry becomes diffuse, overstrained in feeling, quaint and full of conceits—characteristics, some of which

appear even in **George Herbert's** pure, devout and delightful poems (1631)—till at length it emerges once more into beauty and power in the hands of JOHN MILTON, the latest poet of our golden age. To the best qualities of the earlier Elizabethan writers, he adds a grave dignity and religious fervour, which is wanting in most of them; but his lighter poems show that, Puritan though he was, he could enter with a true poetical and human interest into all that was beautiful in nature, art and literature. But had he not been the first English religious poet, he would still be remembered as one of the greatest masters of English prose. In fact, though he published some of his best poems in early youth, twenty of the best years of his middle life were devoted to political controversy, to his efforts in which we owe his magnificent *Areopagitica*. As prose writers of this later epoch may be mentioned **Jeremy Taylor,** the author of *Holy Living and Dying*, and the most spiritual and eloquent of divines; the nonconformist **Richard Baxter,** who wrote *The Saint's Rest*, a book still dear to the hearts of religious English men and women of every school; **Isaac Walton** of the *Complete Angler*, and **Fuller** of the *Worthies*;—and we may include in it, as the last famous writer of the Puritan school, JOHN BUNYAN, of the *Pilgrim's Progress*, which appeared four years after Milton's death.

Here are specimens of the poetry and prose of the Elizabethan age. The first is the commencement of the last canto of the First Book of Spenser's *Faerie Queen*:—

> Behold I see the haven nigh at hand,
> To which I meane my wearie course to bend;
> Vere the maine shete, and beare up with the land,
> The which afore [= ahead] is fairlie to be kend,
> And seemeth safe from storms that may offend:
> There this faire virgin, wearie of her way,
> Must landed be, now at her journey's end;
> There eke my feeble barke awhile may stay,
> Till merry wind or weather call her thence away.

Spenser was the friend of Raleigh and other heroes of

the sea, and takes great delight in expressions and images borrowed from seafaring life.

From Hooker's *Ecclesiastical Polity*:—

Touching musical harmony, whether by instrument or by voice, it being but of high and low in sounds a due proportionable disposition, such, notwithstanding, is the force thereof, and so pleasing effects it hath in that very part of man which is most divine, that some have been thereby induced to think that the soul itself by nature is or hath in it harmony. A thing which delighteth all ages and beseemeth all states; a thing as seasonable in grief as in joy; as decent, being added unto actions of greatest weight and solemnity, as being used when men most sequester themselves from action. The reason hereof is an admirable facility which music hath to express and represent to the mind, more inwardly than any other sensible mean, the standing, rising, and falling, the very steps and inflections everyway, the turns and varieties of all passions whereunto the mind is subject; yea, so to imitate them that whether it resemble unto us the same state wherein our minds already are, or a clean contrary, we are not more contentedly by the one confirmed, than changed and led away by the other. In harmony the very image and character even of virtue and vice is perceived, the mind delighted with their resemblances, and brought by having them often iterated into a love of the things themselves. For which cause there is nothing more contagious and pestilent than some kinds of harmony; than some nothing more strong and potent good. And that there is such a difference of one kind from another we need no proof but our own experience, inasmuch as we are at the hearing of some more inclined unto sorrow and heaviness, of some more mollified and softened in mind; one kind apter to stay and settle us, another to move and stir our affections; there is that draweth to a marvellous grave and sober mediocrity, there is also that carrieth, as it were, into ecstasies, filling the mind with a heavenly joy, and for the time in a manner severing it from the body. So that, although we lay altogether aside the consideration of ditty or matter, the very harmony of sounds being framed in due sort and carried from the ear to the spiritual faculties of our souls, is by a native puissance and efficacy greatly available to bring to a perfect temper whatsoever is there troubled, apt as well to quicken the spirits as to allay that which is too eager, sovereign against melancholy and despair, forcible to draw forth tears of devotion if the mind be such as can yield them, able both to move and to moderate all affections.

CHAPTER VI.

THE CRITICAL AGE, or

The Age of Free Inquiry (1650-1750).—About the middle of the seventeenth century a remarkable change took place in the mode of thought and in the character of the literature of this country. *Free Inquiry* became the order of the day. In theology, in philosophy, in politics, and even in poetry, past history, precedent, and authority were set aside in favour of individual liberty of opinion, and the system of bringing everything as an open question to the arbitration of reason took possession of the whole field of thought and literature. HOBBES led the way with his *Leviathan* (1651), in which he assailed the doctrine of the divine right of kings. Not to linger over lesser names, JOHN LOCKE followed in a similar strain with his treatise *On Human Understanding* in 1690, and BISHOP BUTLER in his *Analogy of Religion* took the same course with **Theology** in 1736.

BISHOP BERKELEY at the beginning of this period (1653) had, in a celebrated treatise, denied the existence of matter; and a controversy, founded on this new philosophy, between the supporters of the doctrines of natural and of revealed religion occupies the first half of the eighteenth century. The orthodox side was taken by BISHOP BUTLER, BENTLEY (more famous as the originator of classical criticism), and BISHOP WARBURTON, author of the *Divine Legation of Moses*. The greatest writers on the sceptical, or, as it was called, deistical side, were LORDS SHAFTESBURY and

BOLINGBROKE, and DAVID HUME the historian. In the writings of Bolingbroke, however they may be condemned in respect of matter, are to be found some of the noblest prose of this or perhaps of any age of English literature.

In Poetry the artificial style now wholly superseded the natural; epigrammatic point and antithesis took the place of nature and feeling and imagination. *Paradise Lost*, it is true, first appeared in 1660, but Milton belongs to the past age. JOHN DRYDEN and ALEXANDER POPE, the poets of this period, turn away from the poetry of the passions, the delineation of which had been the glory of the Elizabethan Age, and concern themselves chiefly with the moral and social aspects of human life. Notwithstanding these unfavourable conditions, the age we are discussing gave birth to some poetry, at least, which will live as long as the English language. Dryden's poems exhibit all the characteristics of this age. They are full of close reasoning, incisive and vigorous expression, combined with ease and harmony of versification. Pope is our great master of didactic and philosophical poetry. It is true that his philosophy is neither original nor profound, but the language in which it is conveyed, however deficient it may seem in feeling and imaginative power, is a model of polished art and masterly expression.

As a **dramatist** Dryden was less successful, and the most notable playwriters of the period are the witty, licentious **Congreve** and **Wycherley**. **Gay** delighted the theatrical world with the *Beggar's Opera* in 1728, and in OLIVER GOLDSMITH'S *She Stoops to Conquer*, and in RICHARD SHERIDAN'S *Rivals* and *School for Scandal* (1768–78), the later English drama culminates and expires.

In this period **Scientific Research** may be said to claim recognition for the first time *in literature*. Sir ISAAC NEWTON took up and carried on the great reform of the method of investigation begun by Bacon, and gave the world the result of a life's labour in his famous *Principia*

(1687). This, of course, was a Latin work, but his *Theory of Light* (1671), and other scarcely less important writings, belong to English literature.

Periodical literature, which has now reached such gigantic proportions, took its rise with the essays of STEELE and ADDISON in the *Tatler* (1709). This period also witnessed the appearance of JONATHAN SWIFT'S *Tale of a Tub* and *Gulliver's Travels*, the first **Political satires,** and, with perhaps the exception of **Sir T. Malory's** *Morte d'Arthur* and of **Lyly's** *Euphues* in the preceding century, the first prose work of **Fiction** in English literature. DANIEL DE FOE, though also a powerful political writer, will always be best known as the author of our next great work of fiction, the *Adventures of Robinson Crusoe.* But the true '**Novel**' of modern times, with plot and play of character combined, which was shortly afterwards carried to such perfection by **Fielding, Smollett,** and **Lawrence Sterne,** is now, for the first time, represented by the *Pamela* of **Richardson,** which appeared in 1740.

Specimens of the Poetry and Prose of the 'Age of Free Inquiry.'

Beginning of Pope's *Essay on Man*, Address to Lord Bolingbroke :—

Awake, my St. John! [pronounced 'Sinjohn'] leave all meaner things
To low ambition and the pride of kings.
Let us (since life can little more supply
Than just to look about us, and to die)
Expatiate free o'er all the Scene of Man,
A mighty maze! but not without a plan:
A wild, where weeds and flowers promiscuous shoot,
Or garden, tempting with forbidden fruit.
Together let us beat the ample field,
Try what the open, what the covert yield;
The latent tracks, the giddy heights explore
Of all who blindly creep, or sightless soar;
Eye Nature's walks; shoot Folly as it flies;
And catch the manners living as they rise.
Laugh where we must, be candid where we can,
But vindicate the ways of God to man.

Lord Bolingbroke on Harley, Earl of Oxford:—

Whether this man ever had any determined view besides that of raising his family is, I believe, a problematical question in the world. My opinion is that he never had any other. The conduct of a minister who proposes to himself a great and noble object, and pursues it steadily, may seem for a while a riddle to the world; especially in a government like ours, where numbers of men, different in their characters, and different in their interests, are at all times to be managed; where public affairs are exposed to more accidents and greater hazards than in other countries; and where, by consequence, he who is at the head of business will find himself often distracted by measures which have no relation to his purpose, and obliged to bend himself to things which are in some degree contrary to his main design. The ocean which environs us is an emblem of our government: and the pilot and the minister are in similar circumstances. It seldom happens that either of them can steer a direct course, and they both arrive at their port by means which frequently seem to carry them from it. But as the work advances the conduct of him who leads it on with real abilities clears up, the appearing inconsistences are reconciled; and when it is once consummated, the whole shows itself so uniform, so plain, and so natural, that every dabbler in politics will be apt to think he could have done the same. But, on the other hand, a man who proposes no such object, who substitutes artifice in the place of ability, who instead of leading parties and governing accidents, is eternally agitated backwards and forwards by both, who begins every day something new, and carries nothing on to perfection, may impose a while on the world; but a little sooner or a little later the mystery will be revealed, and nothing will be found to be couched under it but a thread of pitiful expedients, the ultimate end of which never extended farther than living from day to day. Which of these pictures resembles Oxford most you will determine.

CHAPTER VII.

PERIOD OF THE LITERATURE OF NATURE AND OF MAN.

(1750–1850).—It is usual to date the commencement of the modern period, so strongly characterised by the feeling of the rights and dignity of **Man** as man, from the time of the Great French Revolution of 1792. Many writers have even attributed to that revolutionary crisis the sudden recognition all the world over, of the abstract rights of man irrespective of the differences of birth and fortune; but it would perhaps be nearer the truth to say that these ideas had been growing and ripening long before, and that the outbreak of the pent-up fury of the lower classes against the nobility of France was only a startling manifestation of the spirit everywhere more or less actively at work. With such writers ROBERT BURNS has the honour of being the first English-speaking poet to catch this new enthusiasm of humanity which afterwards found such splendid expression in the songs of **Samuel Coleridge, Robert Southey,** and the later works of WILLIAM WORDSWORTH. But we can clearly trace the influence of the same principles half a century earlier in the writings of THOMAS GRAY (1750), whose *Elegy in a Country Churchyard* (the most perfect gem, perhaps, in the English language) is full of sympathy with and honour for the poor. The same may be said of **Oliver Goldsmith, George Crabbe,** and **William Cowper,** all of whom had written before the year 1792.

In the poetry of Lord BYRON and PERCY BYSSHE SHELLEY, at the beginning of the present century, the spirit repre-

sented by the Revolution extended itself into revolt against the whole established order of society; and not even the fire of genius, the mastery of language, and the heights and depths of pathos and of passion, can redeem the poetry of Byron from the stigma of morbid discontent and rebelliousness against the conditions of human life, to which all must in the long run willingly or unwillingly submit.

But there was another new element introduced into our poetry at about the same period, the *cultus* or worship of **Nature,** in so far as such a 'worship' is compatible with that devout recognition of the author of Nature, which is everywhere to be seen in the works of WILLIAM WORDSWORTH, the greatest, and in one sense the first, English poet of nature. It is true that no true poet can be wholly destitute of the love of nature, and the most beautiful and tender descriptions of natural scenery abound in the poetry of the Elizabethan age. It is also true that in **William Collins,** the contemporary of Gray (1750), in **Oliver Goldsmith,** and in **William Cowper,** the poetry of Nature, which had slumbered since that great age, revived, as that of Love revived from a sleep almost as long, in the songs of Burns. But with Wordsworth for the first time, Nature became, as it were, an object of personal attachment and affectionate delight. To him Nature appeared to have a soul and body of her own; could be loved like a human being, treated like a friend, and worshipped, not as the old Pagans worshipped her, but as the creature of God, the visible embodiment and daily representative to man of His almighty perfections.

It has been necessary, in order to keep up the due proportions of the subject on which we are engaged, to dwell somewhat at length upon the Poetry of this age as most strikingly characteristic of the period, and the portion of the literary field in which its greatest achievements were wrought. Take as a specimen of English prose by a living writer, the following criticism upon it, which needs no apology for its insertion at full length in this brief epitome:—

Exhaustive reasons can hardly be given for the strangely sudden appearance of individual genius during this period; but none can be less adequate than that which assigns the splendid national achievements of our recent poetry to an impulse from the first French Revolution. That revolution, indeed, was rather one result, and in itself by no means the most important, of that far wider and greater spirit which, through inquiry and doubt, through pain and triumph, sweeps mankind round the circles of its gradual development; and it is to this we must trace the literature of modern Europe. But without more detailed discussion on the motive cause of Scott, Wordsworth, Campbell, Keats and Shelley, we may observe that these poets, with others, carried to further perfection the later tendencies of the century preceding, in simplicity of narrative, reverence for human passion and character in every sphere, and impassioned love of Nature—that, whilst maintaining on the whole the advances of art made since the Restoration, they renewed the half-forgotten melody and depth of tone which marked the best Elizabethan writers—that, lastly, to what was thus inherited they added a richness and depth in language and a variety in metre, a force and fire in narrative, a tenderness and bloom in feeling, an insight into the finer passages of the soul, and the inner meanings of the landscape, a larger and wiser humanity—hitherto hardly attained, and perhaps unattainable even by predecessors of not inferior individual genius. In a word, the nation which, after the Greeks in their glory, has been the most gifted of all nations for poetry, expressed in these men the highest strength and prodigality of its nature. They interpreted the age to itself, hence the many phases of thought and style they present—to sympathise with each fervently and impartially, without fear and without fancifulness, is no doubtful step in the higher education of the soul. For as with the affections and the conscience, purity in taste is absolutely proportionate to strength—and when once the mind has raised itself to grasp and to delight in excellence, those who love most will be found to love most wisely.—F. T. Palgrave's *Golden Treasury*, p. 320.

But the achievements of this great age were not confined to poetry. It produced, in **Divinity,** the works of WILLIAM PALEY (1785), works indeed of very unequal merit and importance, but some of them invaluable contributions to theological literature, and all written in language of exquisite perspicuity. The **History** of the period is adorned by the great names of DAVID HUME, author of the first literary *History of England* (1760), and EDWARD GIBBON, of the still more famous *History of the Decline and Fall of the Roman Empire* (1788). The literature, and indeed the science of **Political Economy,** began with the publication of ADAM SMITH'S *Wealth of Nations* in 1776. Dr. SAMUEL

JOHNSON compiled the first English *Dictionary* in 1775, and the art of **Biography** may almost be said to have originated some sixteen years later, with Boswell's famous life of that great man. An extraordinary impulse was given to periodical literature and criticism by the starting of the *Edinburgh Review*, under the auspices of JEFFREY, BROUGHAM, SYDNEY SMITH, and MACAULAY. **Political, Philosophic,** and **Scientific** literature were represented respectively by EDMUND BURKE (1756) and the anonymous author of the *Letters of Junius* (1798);—DUGALD STEWART (1798), and JEREMY BENTHAM (1810);—**Sir William Herschel** (1830), and **Sir David Brewster.** In **Fiction,** LAWRENCE STERNE, OLIVER GOLDSMITH, **Miss Burney, Miss Edgeworth,** and MISS AUSTEN carried the art of novel writing to high perfection; but SIR WALTER SCOTT, whose first work, *Waverley*, appeared anonymously in 1814, may almost be said to have re-created it, by the vividness with which he represented characters and incidents in the romantic history of the past. Persons are still alive who remember the excitement and delight with which the English-speaking world welcomed these earlier productions of the 'Great Unknown;' but they are few who can, and those are now older than the century.

We here enter on **The Age of Contemporary Writers**; that is to say, writers, the oldest of whom may have been personally known and loved by middle-aged men and women of the present day. Of them it is well to speak generally, and with some reserve; the works of such of them as have been thought worthy to survive are accessible through the cheap press, with some little trouble, to all, and may be judged of by all for themselves. The accompanying **Chart** gives in chronological order the names of those who have been most prominent in each department of literature. It may be permitted to say, however, that the literary age in which we live is one to which we may look with reasonable pride. Time—the one final judge—has yet

to make his award; but it does not appear presumptuous to assume that (without specifying other probable names) LORD MACAULAY in **History,** THACKERAY and DICKENS in **Fiction,** and TENNYSON in **Poetry,** are writers destined to an enduring fame.

A specimen of **Prose** by a contemporary and living writer will be found on page 36.

Here is a **Poem** by a contemporary writer; alas! not a living one:—

As ships becalmed at eve, that lay
With canvas drooping, side by side,
Two towers of sail at dawn of day,
Are scarce long leagues apart descried.

When fell the night upsprung the breeze,
And all the darkling hours they plied,
Nor dreamt but each the self-same seas
By each was cleaving, side by side.

E'en so,—but why the tale reveal
Of those whom, year by year unchanged,
Brief absence joined awhile, to feel
Astounded, soul from soul estranged?

At dead of night their sails were filled
And onward each rejoicing steered—
Ah! neither blame, for neither willed
Or wist, what first with dawn appeared!

To veer,—how vain! On, onward strain
Brave hearts! In light, in darkness too,
Through winds and tides one compass guides—
To that, and to yourselves, be true.

But O blithe breeze! and O great seas!
Though ne'er—that earliest parting past—
On your wide plain they join again,
Together lead them home at last!

One port, methought, alike they sought,
One purpose hold where'er they fare—
O bounding breeze! O rushing seas!
At last, at last, unite them there!

Arthur Hugh Clough.

To Sum up briefly:—It will be plain to the readers of the foregoing observations, that nothing in our literature

of an earlier date than the age of Chaucer, that is, the last quarter of the fourteenth century—can be read with pleasure by anyone who is not an Anglo-Saxon scholar, or with profit by anyone who is not an Anglo-Saxon student. The *Vision of Piers Plowman*, and the *Canterbury Tales* and other works of Chaucer and his contemporaries, can be read and enjoyed by an ordinary English scholar with the help of a glossary and notes, such as are to be found in Mr. Morris's and Mr. Skeat's editions. In the prose of Fortescue and More, and in the poems of Wyatt and Surrey, though they differ in many ways from the English of to-day, we do not very often meet with an idiom or an expression which cannot be understood by ordinary unassisted intelligence; and this is as much as can be said of Shakespeare or of Spenser, though they distinctly belong to what is called the Modern Period. From that period onward to the present time the only difficulties to be encountered in the way of *language*, in our reading, arise from involved and clumsy constructions, obscurity of expression, or affectation and *mannerism* on the part of the writer.

CHAPTER VIII.

SELECTION OF PASSAGES FOR COMMITTING TO MEMORY.

It is not necessary or desirable that all our scholars should be poets, but every man or woman living in a civilised society must be, in order to meet the exigencies of everyday life, a writer of prose. Our field of selection, therefore, of passages to be committed to memory, is narrower in prose than in poetry, because learning an author by heart is sure to lead to intentional or unconscious imitation. The passages learned ought, accordingly, to be such as would serve for models in which a proper style might be formed, and in which *archaisms* in words and construction would, of course, be out of place. For the same reason highly rhetorical passages should, as a rule, be avoided, and such as exhibit peculiarities and eccentricities of style. For example, the diction of the great Dr. Johnson's earlier writings is so lengthy, verbose, and ponderous, as to have passed into a proverb. Again, though passages of much picturesque energy are to be found in the writings of Carlyle, the peculiarity of his style and language is such, that a reproduction of it is felt to be an absurd affectation. The same remark applies, though in a less degree, to the eloquent prose of Professor Ruskin, and to the brilliant *History of the Crimean War* by Alexander Kinglake. Copious extracts from both are to be found in many elementary reading books, but it would be unsafe for one not possessing their rare gifts to take either of them as a model for his own style. It is quite true that it

may be hoped what a pupil-teacher learns will influence not so much his *style* of writing as his general interest in literature. But there are such abundant materials for selection in the prose literature of the last fifty years, that, considering the very small quantity of prose required from pupil-teachers (only 120 lines in their whole apprenticeship), it would, perhaps, be wiser not to go much further back than that limit. The language of the Vision of Mirza and even of Lord Chatham's last speech (the favourite selection, perhaps, of all), would seem somewhat stilted and unnatural if used by an essayist or orator of the day.

Poetry, however, occupies a much more important place than prose in the subject of 'Literature,' as prescribed for the instruction of class scholars or pupil-teachers by the Education Department. A scholar who passes through the three upper standards between the ages of nine and thirteen, or a year or two later, will have had an opportunity of becoming thoroughly acquainted with 600 lines of poetry. This, if the selection has been a good one, is no small acquisition, but a thorough teacher will hardly be satisfied if his pupils fulfil the literal requirements of the Code, that is, simply to be able to repeat the passage and understand the allusions. He will endeavour to arouse the faculty of *admiration*, by pointing out beauties in what they are learning which do not lie quite on the surface, and which a child could not be expected to see for itself. It will be his first object, of course, to make his scholar thoroughly understand the grammar and analytical structure of the passage, and to impart the geographical or historical information required, but he will have fallen short of the *ideal* of duty, and thrown away a perhaps irrevocable opportunity, if he confines himself to the dead letter: and fails (1) to illustrate the passage with all the resources at his command; and (2) to bring the heart and intellect of the scholar in contact with the *spirit* of the poem, and to make him feel its grandeur, or pathos, or passion.

It is to be hoped that before very long the subject of 'Literature' will be so expanded or modified as to include some acquaintance, on the part at least of more advanced scholars, with its history and development. Whether this should be the case or not, teachers ought certainly to understand that till some such information has been acquired, their pupils are barely beyond the threshold of a great subject.

It would, indeed, be a serious mistake to undervalue the **mechanical use of the memory.** This interesting faculty is, of course, most active in youth, as those of us who have reached or passed middle age have learned to their sorrow. And it is by no means necessary, in making your selections, to reject such poetry or prose as appeals to higher and more matured faculties than may be supposed to be possessed by boys and girls. Let the passage be carefully committed to memory, explained and illustrated with all care by the teacher, and, even if only partially understood, be left to fructify in the pupil's mind. Then, if it be not forgotten when said to the examiner (and the teacher ought to take steps to prevent its being forgotten when it has served his purpose for the examination schedule, at least so long as the pupil is under his own eye)—if the passage be not forgotten, and be worth learning by heart at all—it will come to be better understood and appreciated as the mind enlarges, and experience and collateral information increase. There are few greater intellectual pleasures in advancing youth than the consciousness of growing *insight*, and of strengthening grasp of mind, thus attested to our inner selves by ability to understand a passage which we once repeated half mechanically. But 'Literature' has this advantage over some of the so-called 'specific' subjects, that the heaviest part of the work of preparation falls upon the scholar, and makes comparatively small demands upon the teacher's time. At a certain stage the task of learning the passage by heart may well be made, to a great extent, home-work, and the portion of time allowed for the preparation of

the subject in school hours may be devoted to explanation and illustration; and to pointing out the characteristics of the passage and of the writer, with reference to the literary age to which they belong, and the circumstances which would seem to have influenced the man and his work.

A few words on Rhyme and Metre:—

Rhyming poetry is, it may be, hardly necessary to say, more easily learned and remembered than *blank verse.* But, if the ear of the learner be properly trained, **rhythm,** as well as rhyme, is a great assistance to the memory; and the teacher should take an early opportunity of explaining the **metre** of the passage of poetry to be learned by heart. Prose, as well as poetry, has a *rhythm* of its own; but even if we take that word in its restricted sense, as equivalent to **metre,** it opens up a subject which is too large to be discussed with anything like completeness in this Manual. A few observations may, however, be useful.

Every **line** in poetry must consist of a certain number of *syllables*, *emphasised* or *unemphasised*, grouped in a certain way. The **metre** of each *line* is determined by the grouping of these syllables into '**feet**' or measures, (1) of **two syllables**, or (2) of **three syllables each**, which is done in **five** different ways—A, B, C, D, E.

(A.) Of **dissyllabic 'feet'** by far the most common is that consisting of a *short or unemphasised syllable followed by a long or emphasised one*, of which 'a**venge**,' 'on **high**' are examples. The great bulk of English poetry is written in lines consisting of **five** 'feet' of this kind, making of course ten *syllables; e.g.*,

> But **mer**|cy **is** | a**bove** | this **scep**|tred **sway**, |
> It **is** | en**thro**|ned **in** | the **hearts** | of **kings**. |
>
> *Shakespeare.*

The general name for this standard English metre is the '**Heroic**': it may be used with rhyme, as by Chaucer, Pope, Goldsmith, and Cowper; or in blank verse, as by

Shakespeare, Thomson, and Wordsworth. The **sonnet**, such a favourite with English poets ever since its introduction from Italy in the sixteenth century (see pp. 21 and 26), consists of fourteen lines of this metre, the rhymes of which are arranged in a somewhat complicated order. *Childe Harold* is written in a '**stanza**' consisting of eight 'heroic' ten-syllabled lines, and one final line of twelve syllables, called an '**Alexandrine**.' This stanza, like the sonnet, was borrowed from Italy, and is called the **Spenserian stanza**, because first made popular in England by Spenser in the *Faerie Queen*.[1] Scott's narrative poems are composed in lines consisting of these same *feet*, but containing eight syllables (or occasionally fewer, for the sake of variety) instead of ten; *e.g.*,

The **stag** | at **eve** | had **drunk** | his **fill.** |

Tennyson's *May Queen* and Macaulay's *Armada*, as will now be seen by a moment's observation, have in each line *seven* such *feet*, or fourteen *syllables*.

(B.) The other **dissyllabic** metres are composed of feet containing *a long or emphasised, followed by a short or unemphasised syllable*, of which '**bright**ly' and '**o'er** me' may stand for examples. The most common of these metres consists of *four* feet of this kind, with the final syllable cut off from the *first*, or from the *second*, line of each couplet for the sake of *euphony*. Of the latter kind is

Deeply | **mourn'd** the | **Lord** of | **Bur**leigh, |
Burleigh | **House** by | **Stam**ford | **town** — |
Tennyson.

Of the former

Lay thy | **bow** of | **pearl** a|**part** — |
And thy | **sil**ver | **shin**ing | **quiv**er. |
Ben Jonson.

Tennyson's *Locksley Hall* contains *eight* such feet, the last syllable being similarly cut off in *every* line:

I the | **heir** of | **all** the | **A**ges | **in** the | **fore**most | **files** of | **Time**— |

[1] See one of Spenser's own 'Stanzas' above (page 28).

(C.) Of **trisyllabic feet,** that most frequently used is made up of *two short syllables followed by a long syllable,* like 'cava**lier**' or 'on the **fold**'; and the most common **metre** made up of such feet consists of **four** of them, containing, of course, twelve syllables—

> At the **close** | of the **day,** | when the **ham**|let is **still.** |
> *Beattie.*

(D.) The less common three-syllabled foot consists of *a long syllable followed by two short,* as in '**woe**fully,' '**call** to them.' An unbroken succession of these feet would weary the ear, so the last two (short) syllables of the line are generally cut off, thus :—

> **Mer**rily, | **mer**rily | **shall** I live | **now**— — |
> **Un**der the | **blos**som that | **hangs** on the | **bough**— — |
> *Shakespeare.*

(E.) The only other trisyllabic foot is so rarely used that it is enough to remember that examples of metres made up of it do exist in English poetry. Here is one, consisting of two such feet in each line :—

> That **in** the | dim **for**est |
> Thou **heard'st** a | low **moan**ing. | *Coleridge.*

In perhaps a less unfrequent form of this metre, the last syllable of the second line is suppressed for euphony :—

> The **black** bands | came **o**ver |
> The **Alps** in | the **snow** — | *Byron.*

Persevering attempts have been made at various times to introduce into English poetry that *mixture* of dissyllabic and trisyllabic feet in which Homer and Virgil wrote, but hitherto with very partial success. Such is the metre of *Evangeline*—

> **Speak**ing | **words** of af|**fec**tion where | **words** of | **com**fort a|**vail'd** **not.** |

Lines, composed of **feet** as described above, may of course be grouped together in a great variety of combinations, on which it is impossible now to enter; but a con-

siderable step will have been gained if the learner is made to understand the structure of the *single* line.

It should be borne in mind that poets not only allowably but laudably, and sometimes most effectively, neglect the strict rules of the metre in which they are composing. For example, in the dialogue of his plays, Shakespeare frequently adds a *syllable* to the legitimate number of the line, thus :—

> Most **po**|tent, **grave** | and **rev**|**erend** |'**signiors**, |
> My **ver**|y **no**|ble **and** | approv'**d** | good **mas**|(*ters*),
> That **I** | have **ta'en** | **away** | this **old** | man's **daugh**|(*ter*)
> It **is** | most **true**.

Again, in long dissyllabic metres, which have a tendency to weary the ear, three short syllables are frequently substituted for a short and a long, thus :—

> | *Many a* | light **fish**|ing **bark** | put **out** | to **pry** | a**long** | the **coast**. |
> *Macaulay.*

Or a syllable is omitted altogether, thus :—

> The **Voice** | which **now** | is **speak**|ing — | may **be** | be**yond** | the **sun**. |
> *Tennyson.*

So, too, in the matter of **emphasised** and **unemphasised** syllables, poets not only allowably but laudably at times '*misplace*' an emphasis, and force it on a particular syllable, which strict attention to metre would require to be unemphasised, thus :—

> Of **man's first** disobedience and the **fruit**. *Milton.*

Which should be read as here indicated, though according to *metre* it should be accented thus :—

> Of **man's** | first **dis**|**obed**|ience **and** | the **fruit**.|

Again, the word '**intense**' is of course strongly emphasised on the last syllable; but the following line may almost be said to be raised out of prose into poetry by the *metrically wrong* position in which that word is inserted in it :—

> — | a **ray** |
> Of **in**|**tense glo**|ry on | th' ho**riz**|on's **brim**. | *Moore.*

—The poet, however, though not *fettered* by his metre, is always *conscious* of its restraints, and the departures which he makes from them are like 'exceptions which prove a rule.' And this same principle should guide the reader and reciter. He too should always be *conscious* of the metre and its restraints, but should be more studious of catching and of rendering the feeling of the passage and the melody of the verse, than of the regular beat of the accents and the laws of syllabic construction. The following example may throw some little light on a difficult subject. *Metre* would require us to read the last stanza dealt with at the beginning of Chapter IX., thus:—

> Be**neath** | those **rug**|ged **elms**, | that **yew** | tree's **shade**, |
> Where **heaves** | the **turf** | in **man**| y a **mould**|'ring **heap**, |
> Each **in** | his **nar**|row **cell** | for **ev**|er **laid**, |
> The **rude** | fore**fath**|ers **of** | the **ham**|let **sleep**. |
>
> *Gray's Elegy.*

The Poet, as I take it, *meant* us to read the stanza thus:—

> Be**neath** those **rug**ged ELMS, that **yew** tree's **shade**,
> Where **heaves** the **turf** in many a **moul**dering **heap**,
> **Each** in his **nar**row CELL for ever **laid**,
> The rude **fore**[1]fathers of the **ham**let **sleep**.

[1] *A 'forced' emphasis.*

A teacher cannot begin better than by requiring his pupils to write out fairly, with minute attention to punctuation and rhythmical arrangement, the whole of the passage. If the poetry selected be of a dramatic or narrative kind, like that of Scott or Macaulay, the teacher would do well either to make the pupils write out in their own words the sequence of the incidents in the narrative; or, if he thinks they are not quite up to doing this, supply them himself with such a key to the story. Again, in the course of the year allowed for preparation, it is not too much to expect that every portion of the passage, without exception, shall have been *analysed* and *paraphrased* either orally or on paper; the out-of-the-way words *parsed*, and the constructions cleared up, e.g., by supplying ellipses and

reading *inverted* into *direct* sentences. Over and above the more obvious utility of such exercises, they have the effect of forcing the mind to dwell *deliberately* on every sentence, look it round on all sides, and view it in organic connection with the context. By the use of the above means, a teacher may expect to make sure (1) that a clear and defined, instead of a blurred image of the sentence will be presented to the mind, for the memory to work upon; and (2) that the actual process of learning by heart will be *associative*, *intellectual*, and almost *automatic*, instead of being artificial, mechanical, and laborious.

It is hoped that the historical sketch above given, and the **Chart** at the end of the Manual, will be some guide to the teacher in the selection of suitable passages for recitation, even if that be not the primary object of either. Literature of a strictly religious character is (implicitly) excluded from choice ; but, as it is desirable to make the exercise conducive to the creation of a healthy moral tone in the pupil, such passages should, *cæteris paribus*, be selected as breathe and inculcate a spirit of gentleness and self-sacrifice, or of duty, fortitude, and patriotism.

The selections sometimes made are, in a high degree, capricious and even reckless. A teacher proposes, we will say, the *May Queen* of Tennyson *as an alternative* to Gray's *Elegy*, in apparent unconsciousness of the enormous difference in the difficulty of preparing the two. It is one of the charms of the former poem that there are no inversions, allusions, or 'classicisms,' or next to none, to be found in it. There is scarcely a line of the latter, for the thorough comprehension of which a boy or girl can dispense with a teacher's help ; and it is hardly too much to say that (leaving verbal memory out of the question) half-a-dozen stanzas of the *Elegy* would involve more labour in preparation than twenty of the *May Queen*. Compare—

> Little Effie shall go with me to-morrow to the green,
> And you'll be there too, mother, to see me made the queen.

With—

> Can *storied urn* or *animated bust*
> Back to *its mansion* call the *fleeting* breath?

It is hard to see what questions an examiner *could* ask, excepting in grammar, on the former couplet;—to give an intelligent explanation and illustration of some *six* or *seven* words in the latter, would be no small credit to teacher and pupil. While, therefore, no teacher would be summarily forbidden by a judicious adviser to take up the *Elegy*, he ought to do so with his eyes open, and with due warning of the difficulty, and, perhaps, ambitiousness of the undertaking.

CHAPTER IX.

PRACTICAL SUGGESTIONS.

As we are on the subject of Gray's *Elegy*, however, we will take two stanzas of it for detailed examination, and endeavour to show from them (1) **what an examiner would expect** from scholars who had been preparing this poem, and (2) **what he would be gratified at getting out of them.**

Beneath those rugged elms, that yew-tree's shade,
Where heaves the turf in many a mouldering heap,
Each in his narrow cell for ever laid,
The rude forefathers of the hamlet sleep.
* * * * * * *
Oft did the harvest to their sickle yield:
Their furrow oft the stubborn glebe hath broke:
How jocund did they drive their team afield!
How bowed the woods beneath their sturdy stroke!

(1) An examiner would **expect** them to be able to read both stanzas in **prose order,** taking subject, predicate, and direct or indirect object, in their logical sequence, and attaching the subordinate clauses to the words to which they respectively belong. Unless they can do this, it is next to impossible to discover whether children understand such a passage at all. Thus:—the first stanza is absolutely turned topsy-turvy. In the order of analysis, it begins with the bottom line, and works back up to the top. 'The rude forefathers of the hamlet, each laid for ever in his narrow cell,—sleep where the turf heaves in many mouldering heaps beneath those rugged elms (and) that yew-tree's shade.' In the second stanza the inversions are not of the sentences,

but of their constituent parts. Thus: 'Oft(en) did the harvest yield to their sickle: Oft(en) hath (has) their furrow broke(n) the stubborn glebe: How jocund(ly) did they drive their team afield (to the fields): How the woods bowed beneath their sturdy stroke.' Again, he would **expect** the scholars to be able to name the *class* of labourers described in each line respectively, of the second stanza,—the reapers, the ploughmen, the carters, the woodmen. He would expect them to be able to point out the words in poetical *form* in the passage, *e.g.* (in stanza 2) 'oft,' for often, 'hath' for has, 'broke' for broken, 'jocund' as an adverb, 'many a heap' for 'many heaps.' Nothing less than this, combined with a satisfactory *repetition* of the passage, ought to secure a 'pass.'

(2) An examiner would be **gratified** at their being able to tell him the few words not of Anglo-Saxon origin in the passage,—'cell,' 'rude' (not here='surly' or 'ill-mannered,' but in the classical sense of the word='simple,' 'unlettered,') 'sickle,' 'glebe,' 'jocund';—the *primary* meanings of 'harvest' (*i.e.*, the *time of year*); 'team' (a long *progeny*)—any interesting facts connected with the history of any of the words, *e.g.*, 'many a'—a poetical form, of pure *Danish* origin; 'sleep,' for taking rest in death—a Christian idea—compare 'cemetery';—'sickle,' its connection with 'Sicily,' anciently 'Zancle,' or 'the sickle';—at their having been made to understand why the passage is *poetical*, and would still be so, even if denuded of its poetical forms and inversions—why? because action or volition is attributed to inanimate things; the 'turf' 'heaves'; the 'harvest' surrenders; the 'furrow' (not the plough that makes it) breaks the glebe, for all its 'stubborn' obstinacy; the 'woods' bow their heads in submission to the wielders of the axe. Lastly, he would like to find that they knew *something* of the author's individuality, to what period he belonged, and how his beautiful work illustrates the spirit and culture of his literary age;—knew of any *contemporary*

author who also delighted in the companionship of Nature, and felt, with Gray, the dignity and pathos of Human life and character, irrespectively of 'class' differences. Is this too much to look for as the result of a twelvemonth's preparation of from one to three hundred lines?

Though some hints have been given above (pp. 46 & 47) on *accent* and *emphasis* in connection with **metre,** nothing has yet been said on the subject (not, indeed, dwelt on in the Education Code, but of too much importance to be passed over in silence) of **repeating with proper feeling and expression.** It may be said that this depends chiefly on the scholar's having been made to understand the passage and enter into its spirit, and partly on his own natural feeling and refinement. It does so, of course, to a great extent; but (in the opinion of the writer) this, like everything else connected with the exercise, is chiefly a matter of good *teaching*. He was once present on an occasion when a certain girl pupil-teacher came up before the Government Inspector to repeat the first part of the *May Queen*. The poor girl had a staring expression of Bœotian dulness on her broad but not uncomely face, and her voice seemed no more capable of an undertone than that of a calf. She knew her task quite perfectly, and had an answer ready for the two or three questions which could possibly be asked about the meaning of the words; but the recitation was so completely devoid of feeling and expression, and so stolidly monotonous, that it would have been amusing, had it not been painful, to listen to it. It happened that there was among the audience a lady living near the village—the daughter of the most gifted of all the tragic actors of the English stage;—and she was so painfully impressed by the 'desecration' which she had just witnessed of an exquisite work of genius, that she announced her intention of taking the pupil teacher in hand herself, and teaching her the two remaining portions of the poem by that time next year. She fulfilled her promise, and feeling her resolution rise with the

difficulty of the task, she hardly missed a day, never a week, except when absent on the Continent, in going through each verse over and over again with her pupil during the year, till the girl could repeat it to her satisfaction. When the day arrived, the pupil came forward once more before some of the persons who had heard her on the previous occasion. We fancied that she looked a good deal brighter and more intelligent than before, but when she began to repeat the '*New Year*,' it was hard to believe that she was the same individual. Her voice was properly modulated, her pauses and emphasis just as marked as they should have been, and no more; her articulation delicate, her expression unforced and tender; and before she had concluded there were few eyes undimmed among the listeners. Of the *fact* there could be no doubt; was it then only a marvel of mechanical teaching, or had the girl's whole moral and intellectual nature been refined in the process?

CHAPTER X.

COMPOSITION EXERCISES.

By the Education Code a composition exercise, adapted to three stages of proficiency, is required, in addition to the repetition of a passage of poetry, from all scholars on whose behalf a grant is claimed under the head of Literature.

In the first stage they are required 'to write a letter on a simple subject;' in the second, 'to paraphrase a passage of easy prose;' in the third, 'to write a letter or a statement, the heads of the topics to be given by the inspector.' It may be expected that a few hints should be given on these heads.

First, as to the *form* of a letter, the teacher does not, or ought not to need any directions. A knowledge of the proper position on the paper of the date and place of writing and of the forms of address and of subscription is easy enough of acquisition; though with reference to the former a teacher might find it difficult to explain and a pupil to understand why, beginning with simple 'Sir' and ascending through more and more respectful forms of address to persons of higher rank, we come back again to 'Sir' in addressing a Prince of the Blood Royal;—or with reference to the latter, why we represent ourselves as 'sincere' to friends, and only 'faithful' and 'true' to acquaintances, 'respectful' to newspaper editors, and 'obedient' to strangers. But these are matters of mechanical detail, on which it is unnecessary to enter.

When once we are secure of our grammar and spelling, the main secret of writing a good *business* letter is clear-headedness, combined with straightforwardness and civility, accuracy and conciseness; all of which may be matters of intellectual acquirement. The secret of writing a good *private* letter is, in one word, sympathy—a moral endowment, for the cultivation of which there is a Golden Rule, and no other can be given.

As for the essay, or '**Statement**,' it is much to be regretted that this, or some other such exercise, does not now come earlier, and enter more largely into the requirements of the Department. Educators of an older generation will remember what a prominent position it occupied in the daily routine work of the upper classes before the introduction of the Revised Code; and how interesting it was to watch how an intelligent scholar went about the task—first setting his brain to work to think of all the facts he knew connected with the given subject, then selecting the most important and interesting of them; putting these into his best language; and, perhaps, according to time-honoured custom, winding up with a little moral at the end. There is no better exercise,—none which calls a greater number of faculties into play,—and it should be made the most of by teachers whenever an opportunity of practising it is given.

Lastly, as for the **Paraphrase** of a passage of prose. To do this well is by far the most difficult achievement of the three. Paraphrasing poetry is a different thing. The frequent inversions, the broken constructions, the exalted language which are characteristic of poetry, would be inadmissible in prose; the poetry of the passage can in fact be only too easily extracted, and another version substituted, which, though altogether inferior in grace, energy, and picturesqueness, is still not a painful contrast to the original, because one *is* poetry and the other prose. But to attempt to rewrite a well-written passage of *prose* generally ends by

turning good English into bad, and producing, not a paraphrase, but a clumsy *periphrasis*, or circumlocution. The exercise, nevertheless, has its value; and it consists in this, that in teaching persons who are acquainted with one language only, it is the best, and indeed the sole, substitute for *translation*, which enters so largely into what is called the higher education.

There is more than one cheaply procurable textbook devoted to the subject of paraphrasing, which is indeed somewhat loosely and arbitrarily connected with that of a Literature manual. One or two examples and observations upon it may however be suggestive, if nothing more, to those who look for some mention of the subject here.

We must, as a general rule, be content with showing that we have grasped the meaning of the passage, by expressing it in different language (which shall be at least straightforward construable English)—and with as little circumlocution as possible. 'Paraphrase,' says Dryden, 'is a translation with latitude; the author's words are not so strictly followed as his sense.' We are not at liberty to bring out that 'sense' by an 'introduction' at the beginning, or by a running commentary as we go along, or by drawing a moral at the end; that would be not a paraphrase but an *Exposition*. Nor must we be content with a mechanical substitution of one word for another; that would be, not a paraphrase, but a lifeless *Metaphrase*. Our version must be capable of standing alone,—standing in the place of the author's own words if they should be lost or forgotten; it must be good honest 'change' for the original, even if it should be silver given for gold. Mr. Hunter takes for an example a well-known passage from Blackstone's *Commentaries*,

The Royal Navy of England hath ever been its greatest defence and ornament; it is its ancient and natural strength; the floating bulwark of the island;

and he paraphrases it thus: 'Our royal navy has ever been

the chief source of our country's security and glory—it is our ancient strength, as being naturally suited to our insular position—the floating bulwark,' &c. On this paraphrase it may perhaps be remarked (1) that '*ancient strength*' is perhaps a more vague and indeterminate expression than would be found in this connexion in good prose of the present day; and (2) that the use of the phrase '*as being*' involves an *inference* not apparent, or certainly not expressed, in the original; and (3) 'suited to our *insular position*' (instead of '*circumstances*' or some such word) is rather too much of an 'expository' version of the epithet 'natural.' But your pupils will do yourself and themselves credit if they produce anything like as good a paraphrase as the above.

'*Floating bulwark*' is wisely let alone; *metaphors* are some of the most difficult things to deal with in paraphrase. It sometimes indeed occurs that by a happy accident—for it is nothing more—we are able to substitute a familiar and easy metaphor for a kindred but unfamiliar and difficult one, as in the instance 'He clothed himself with cursing,' which might be familiarly rendered by 'He was in the *habit* of cursing.' Metaphors, however, must generally either be let alone, or converted into *similes*, which differ from metaphors in being introduced by 'like' or 'as.' Thus, 'A deluge of disasters overwhelmed the country' is a metaphor; 'Disasters overwhelmed the country like a deluge' is a simile.

To conclude with another example which may or may not be thought a little more difficult than that from Blackstone. A statesman says in the House of Commons:

Our foreign policy has up to the present time been based upon the traditional creed of our countrymen—a creed now something over two centuries old—that England's appointed mission is to maintain the balance of power on the Continent.

This having been, we will suppose, 'imperfectly heard by the reporters in the gallery,' reappears in the morning papers in

the following form : 'In our dealings with foreign countries we have acted hitherto upon the national belief,—a belief handed down from father to son for some seven generations of Englishmen,—that Great Britain has been Divinely appointed to counteract the undue preponderance of any single European Power.'

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PERIODS	POETRY: DRAMATIC	POETRY: PHILOSOPHICAL	POETRY: IMAGINATIVE	POETRY: RELIGIOUS	PROSE: RELIGIOUS	PROSE: HISTORICAL	PROSE: PHILOSOPHICAL	PROSE: BIOGRAPHICAL	PROSE: CRITICAL	PROSE: FICTION	PROSE: TRAVELS	PROSE: ESSAYS	PROSE: SCIENTIFIC	PROSE: TRANSLATIONS
ANGLO-SAXON (450–1066) A.D.				CÆDMON (670 A.D.)		KING ALFRED (Anglo-Saxon Chronicle) (878)								Bæda (750) (St. John's Gospel) King Alfred
SEMI-SAXON (1066–1200)			Layamon (The Brut) (1200)			Bishop Wulfstan (A. S. Chronicle) (1090)								
EARLY-ENGLISH (1200–1350)			Robert of Gloucester (Riming Chronicle) (1298)	Ormin (The Ormulum) (1215)										
MIDDLE-ENGLISH (1350–1450)			CHAUCER (1328–1400) 'Piers Plowman' (1392) Gower (1392) Occleve (1420) Lydgate (1430) *Scotch* Barbour (1375) James I. (1422)		Wicliff (1380)						Sir J. Mandeville (1370)			WICLIFF (1380) Trevisa (1387)
Age of First Printed Books (1450–1550)			Robin Hood—and other Ballads Sir T. Wyatt } Earl of Surrey } (1540)		Bishop Pecock (1450) Bishop Latimer (Sermons) (1549)	Sir T. More (1510)	Sir J. Fortescue (1450) Ascham (1545)			Sir T. Malory (1485)				CAXTON (1474) Tyndale (1525)
Elizabethan Age (1550–1650)	Udall (1506) Greene and Marlowe } (1587) SHAKSPEARE (1590–1612) Ben Jonson (1596) Beaumont and Fletcher } (1610) Massinger and Ford } (1630) Shirley (1650)	Davies (1600) Lord Brooke (1600)	Sackville (1559) Gascoigne (1576) SPENSER (1553–99) Sir J. Suckling Herrick Lovelace Drummond Milton (Minor Poems) } (1630) Waller (1640)	G. Herbert (1631)	Hooker (1594) Jeremy Taylor (1647)	Holinshed (1577) Sir W. Raleigh (1616) Camden Speed } (1615)	BACON (1597)		Sir P. Sydney ('Defence of Poetry,' *Beginning of English Criticism*, 1580) Puttenham (1589)	Lyly (1579) Sir P. Sydney (1580)	Hakluyt (1589) Purchas (1625)			Coverdale (1505) Chapman ('Homer,' 1598)
MODERN-ENGLISH: Age of Free Inquiry (1650–1750)	Dryden (1663) Wycherley and Congreve } (1680) Otway (1675) Gay (1728)	Butler (1663) Pope (1688–1744)	MILTON (Paradise Lost; 1660) Pope (1710) Thomson (1730)	Bishop Ken (1668) DRYDEN (1631–1700)	Chillingworth and Hales } (1650) Barrow (1657) BUNYAN (1628–88) South (1700) BISHOP BUTLER (1692–1752) Bishop Warburton (1745)	Lord Clarendon (1670) Bishop Burnet (1700) Robertson (1759)	Hobbes (1651) Bishop Berkeley (1653) SIR I. NEWTON (1642–1727) LOCKE (1690) Lord Bolingbroke (1700) Hume (1710)	Fuller (1652) Izaak Walton (1653)	Bentley (*Beginning of Classical Criticism*; 1697) Bishop Warburton (1745)	SWIFT (1667–1723) De Foe Richardson ('Pamela,' *First English Novel*; 1740) Fielding (1742) Smollett (1748)	Bruce (1760)	Addison Steele } (1709) (*First 'Periodical'*)	Sir I. Newton (1671) (*Science first recognised in Literature*)	Pope (1725; 'Homer.')
			GRAY (1716–71) Collins (1750) Chatterton (1760) Goldsmith (1770) Beattie (1774) Crabbe (1783) Cowper (1785) BURNS (1759–96) Rogers (1792) Southey (1794) Coleridge (1796) WORDSWORTH (1770–1850)			HUME (1711–76) GIBBON (1737–94)	Priestly (1756) Burke (1756) Reid (1760)			Sterne (1775) Goldsmith (1776) Miss Burney (1778)			Sir W. Blackstone (1755) (Law)	
Age of the Literature of Man and of Nature (1750–)	Goldsmith and Sheridan } (1770)		Campbell (1799) Scott (1812) Moore (1812) LORD BYRON (1788–1824) SHELLEY (1792–1822) Hogg (1813) KEATS (1796–1821) Mrs. Hemans Procter (Barry Cornwall) Miss Procter Hood Mrs. Browning Kingsley Clough &c. &c.	Keble &c. &c.	Paley (1785) Coleridge (1796) Channing (1819) Chalmers (1820) Dr. Arnold Professor Mozley &c. &c.	Lingard (1819) Sir W. Napier (1820) Hallam Milman Lord Macaulay Grote Bishop Thirlwall Bancroft Prescott Motley Sir F. Palgrave Lord Stanhope &c. &c.	ADAM SMITH (1723–90) Sir W. Hamilton (1780) Coleridge (1796) Letters of Junius (1770) Bentham (1790) Dugald Stewart (1798) Mill Buckle &c. &c.	Boswell (Life of Johnson, 1791) Southey (of Nelson, 1794) Lockhart (of Scott) &c. &c.	Warton (1774) Dr. Johnson (1775) Jeffrey (1802) Hazlitt (1820) De Quincey Landor Crawford Pennington &c. &c.	Miss Edgeworth (1802) Sir W. SCOTT (1771–1832) Miss Austen (1775–1817) Mrs. Trollope Hook Bulwer Miss Mitford Marryat Dickens Thackeray Miss Brontë Kingsley &c. &c.	Warburton &c. &c.	Brougham Lord Jeffrey Sydney Smith } (1800) Professor Wilson (1820) Lamb (1822) Lord Macaulay &c. &c.	Sir D. Brewster (1831) Hugh Miller (1850) Sir W. Herschel (1864) Dr. Whewell Sir C. Lyell Sir R. Murchison Clerk Maxwell &c. &c.	Cary ('Dante,' 1820) &c. &c.
Living Authors (1879)			TENNYSON Browning M. Arnold &c. &c.	Archbishop Trench &c. &c.	Newman Pusey Bishop Lightfoot &c. &c.	Carlyle Freeman Froude Kinglake Lecky Stubbs Green &c. &c.	H. Spencer Bain &c. &c.	Dean Stanley (of Arnold) &c. &c.	Carlyle Ruskin M. Arnold Muller Morley &c. &c.	D'Israeli Trollope George Eliot Miss Yonge &c. &c.	Kinglake Dean Stanley &c. &c.	Carlyle Goldwin Smith &c. &c.	Owen Huxley Tyndall Sir W. Thomson &c. &c.	

N.B.—When a *single* date is given, it represents approximately the period of the author's greatest literary activity.

HOW TO TEACH LANGUAGES.

'As this is a question of fact, not of abstract science, we can only expect success by following the experimental method, and deducing general maxims from a comparison of particular instances. The other scientifical method, where a general abstract principle is first established, and is afterwards branched out into a variety of inferences and conclusions, may be more perfect in itself, but suits less the imperfection of human nature.'—HUME.

CHAPTER I.

PRELIMINARIES TO THE STUDY OF LANGUAGE.

1. **What is to be learnt.**—In the Fourth Schedule to the New Code we find, among other specific subjects, instruction in which is optional, in elementary schools, the following—

	Latin.	French and German.
1st Stage.	Grammar to end of regular verbs.	Grammar to end of regular verbs. Ten pages of a vocabulary.
2nd Stage.	Irregular verbs and first rules of syntax. Knowledge of delectus or other first Latin reading-book. Translation of simple sentences of English (three or four words) into Latin.	Grammar and translation into English of easy narrative sentences. Ten pages of a conversation-book approved by the Inspector.
3rd Stage.	Latin grammar. Cæsar, 'De Bello Gallico,' Book I. Somewhat longer sentences to be translated from English into Latin.	Grammar and knowledge of some easy book approved by the Inspector. Translation of conversational sentences into French or German, as the case may be. Tolerable correctness of pronunciation.

2. Who is to learn it.—According to the rules of the Code, these, like other specific subjects, may be taken up by children on entering Standard IV. (Art. 21 (a).)

It is probable, however, that the intention of the Code is that Languages at least should not be begun until a child has passed St. IV.; for Art. 21 (b) provides that a scholar who has passed St. VI. may be presented for examination in these subjects, which would be impossible if he had begun them all while in St. IV. It is, therefore, to be presumed that the more advanced subjects were not expected to be taken up till the scholar had passed St. IV. at least. Among the more advanced, I think there is no doubt that languages would be reckoned.

I am persuaded, at any rate, that it is generally undesirable that languages should be begun in any standard below the fifth, for the reasons given in the next paragraph.

3. Preliminary requirements.—A child ought to have learnt the rudiments of grammar and the meaning of the rudimentary grammatical terms in English. He ought to know enough of geography to enable him to realise that there are foreign countries in which other languages are spoken, and enough of history to realise that there were other days when Latin was spoken.

I shall, therefore, assume that the children have the amount of grammatical knowledge indicated above, and further know something of the historical and geographical world, before they are introduced to the study of a foreign or dead language.

4. Special preliminary lessons on geographical and historical aspects of the study of language. —Though they have this knowledge, however, it must not be assumed that they will see its bearing, or bring it to bear, on the subject of languages of their own accord. The course of special lessons should therefore be preceded by

some general lessons on the historical and geographical aspects of language, the object of which should be to get the children thoroughly to grasp the fact that languages are not mere inventions for mental gymnastics, but realities, as real to the nations speaking them as English is to us. Again, an English sentence should be taken as text for a lesson, and all the words in it of Latin or French origin, as the case may be, picked out; the value of the foreign tongue and its influence on our own may thus be brought out very forcibly, and you may excite a curiosity to know something more of these sources of English. For German, the course would be only slightly different, the point to be brought out in this case being that English is in fact a form of German. General lessons of this sort should not only precede the special course, but should also be given from time to time between the special lessons, partly to relieve the drier parts of the subject, and partly to keep up the vitality of the instruction.

CHAPTER II.

ON GRAMMAR.

1. Referring back to the Code, you see that the course in each case begins with 'Grammar'; a branch of study which is somewhat repulsive, for not only does it bristle with technical terms, but the terminology is itself more than usually crabbed; in general, the terms employed cannot be understood without a previous knowledge of Latin.

But it has been asked—why learn these technical terms? Why learn grammar at all? Why not learn a foreign or a dead language by a similar process to that by which we learned our own tongue? These are weighty questions; and the replies to them bear so immediately on the matter in hand, that I propose to make the consideration of them a preliminary to the treatment of the main portion of my subject.

2. **Reasons for making grammar part of course of study.**—First: why should we not learn, say, Latin as we did English, i.e. by imitating sounds and by storing our memory with the ideas which those sounds represent? Well, if our only object were to express ourselves in a foreign language as we do in our own, I should say there was no sufficient answer to be given to this question. But is this our only object? I think not. There are two very important faculties which may be brought to bear on the study of language—the faculty of analysis, and the faculty of comparison—which in the imitative method of

learning would be practically unused. For it is by the analysis and investigation of language that we first learn to classify words according to their functions: by the same process we are led to notice that certain words under certain circumstances are more or less modified in form. Comparison shows us that similar or analogous modifications occur in all similar words under the same circumstances; and hence we arrive at the general ideas of case, gender, number, tense, &c., which we sum up in the name 'Accidence.' Again, when we analyse and compare the circumstances under which these modifications occur, we are able to recognise the similarity of them, and thus we can lay down certain general rules: as, for instance, where we find the object of every transitive verb in the accusative case, we think ourselves justified in laying down a rule that transitive verbs govern the accusative. We find that all finite verbs following a conjunction expressing consequence are in the subjunctive mood, and we frame a rule for our own use accordingly, &c. Hence we get 'Syntax,' or the art of fitting words together correctly according to the circumstances in which they are used.

3. **English grammar insufficient for this purpose.**—But why should not all this explanation and information be given in the course of the study of English Grammar? You say you require a child to have learnt the rudiments of grammar before undertaking a language: has he not then got over these difficulties already? This is so to a certain extent; but we soon find that our English grammatical apparatus is inadequate for other tongues, and we must either enlarge it as we go along, or complete it up to the necessary point before starting. Take an illustration from number, gender, and case. English has two numbers, singular and plural; Greek and Sanskrit add another, the dual. English has but two oblique cases, possessive and objective; German and Greek have three; Latin adds a

fourth; Sanskrit a fifth and sixth (without counting the vocative in each case). Again with gender; the neuter gender, which is negative in English, i.e. simply denies sex, and which merges entirely in French, reappears in other languages as a very positive idea, equivalent for all purposes to a third sex. But, in fact, the idea of sex has been entirely superseded in other languages by the grammatical idea of gender; for instance, what are the genders of 'village, room, roof'? Neuter or non-gendered—says the English grammarian; masculine, feminine, and neuter—says the Latin. Again, the English language has by a process of attrition[1] lost so many of its angles, that words really unlike one another have become apparently the same: as in the nominative and accusative cases of nouns, which have lost the terminations by which they used to be distinguished; and in the participial infinitive of the verb (as in 'seeing is believing'), which we cannot distinguish in form from the present participle. Again, there are in English some inherent ambiguities, so awkward as to have misled people who ought to have known better; e.g. the use of 'might' in such phrases as these, 'He told him that he might go to London'; meaning—had leave to go to London; 'He took the train that he might go to London more quickly,'—where 'might' is only an auxiliary of the subjunctive mood.

Now, there are two conclusions that I wish to draw from this. The first is the one which we more immediately want, i.e. that the grammatical frame-work or internal skeleton of English is insufficient for the support of other languages, and that we must enlarge or supplement it, as I said before. Secondly, I would point out to teachers that the comparison of the grammar of one language with that of another is in itself a very valuable method of bringing the intellect into play, and one of which they should avail themselves whenever the opportunity presents itself. If it

[1] Attrition, 'rubbing together;' pebbles on a beach, which were once angular fragments of rock, have become round by *attrition*.

be objected to this that the analysis and comparison is all the teacher's, not the scholar's, I reply that this is to beg the whole question, and assumes a stolid and unintelligent method of teaching, against which these Manuals are especially directed.

4. We must put up with the crabbed terminology of grammar till a better is invented.—Still, it may be said, if we must have grammar, why must its language be so crabbed, and its terms so unintelligible? Well, we have the inheritance of the ages, and we must accept it with all its inconveniences until we can invent something better. The attempt has been made in German to invent more intelligible terms, but with only partial success; for instance, they say Neben-wort, *neighbour-word*; and Beiwort, *subsidiary word*: which of these should you think meant adjective, and which adverb? Again, they say Zeitwort, *time-word*, a capital name for an adverb of time—but it means a verb. For the present, at any rate, therefore, it will be advisable to accept the old established set of names.

5. Grammatical terms must be explained and illustrated.—I therefore agree with the Code in requiring for the study of any language a sound substratum of grammar. But I would insist, as a first axiom of teaching language, that no grammatical term be used as a mere empty symbol, if it is capable of explanation and illustration.

You will doubtless ask me, whence and how are we to get these explanations? I can only answer—from people who understand the matter. Books will not help you much, those at least that are within ordinary reach. Some grammarians give a little explanation, with illustration, but of a meagre description; while the majority introduce children to words like 'dative' and 'ablative' with as little ceremony or explanation as if the meaning of them were as self-evident as that of 'currant-bun.' Still, as I trust nobody will be set to teach this

or anything else except after competent instruction, a teacher will have found some means of acquainting himself with these matters. The present is neither the time nor the place for an exhaustive discussion thereon, but I hope to be able to give a few illustrations of my idea before I have done.[1]

6. On the comparative importance of grammar in the study of Latin, French, and German.—Whatever be the language which it is proposed to study, I think the teacher should take the principle of the foregoing observations to heart. At the same time it must be admitted that the practice must vary according to the language. Thus, in learning Latin, grammar will be the chief point, and the use of the language will be subsidiary. In French the language will be the principal, and the grammar (which labours under many of the defects of our own) will be secondary. German holds a middle place between the two; the language is as important to us as French, while the grammar requires much attention.

To put it in another way, if we were to learn Latin imitatively, as we learned English in our babyhood, we should not have gained much; if we learned French and German in that manner, we should gain a great deal. On the other hand, if we could learn grammar out of Latin, even without learning a word of the language, we should have added enormously to our thinking power; if out of German, we should have added a good deal; if out of French, we should have added comparatively little to what we had already got out of English. This difference is recognised in the Code by the injunction to learn 'Vocabulary' at the very beginning of the course in French and German, an injunction which is absent under the head of Latin.

The method of teaching therefore will vary according to the language, as I shall have occasion to point out later.

[1] See also Appendix to *Public Schools Primer*.

CHAPTER III.

ON LEARNING BY HEART.

1. I will now address myself to the question, what part memory should play in the matter of learning a language, or, how much and what sort of learning by heart should be asked for. This is one of the points on which most people are agreed in theory, but in which there is considerable backsliding in practice. No one will go far wrong in this matter who bears in mind that education is partly an inductive and partly a deductive process; that is, we either make for ourselves general rules out of a number of instances in which we observe a common feature, or, the general rule being given, we apply it to particular cases. It may be said that the inductive process is now in abeyance, as all the general rules that we have usually to deal with have been discovered long ago. Still, a rule is not a rule till it is accepted and realised as such; and the proper office of a teacher is so to present the particular instances to the scholar (at least while he is new to the method) that his attention may be at once arrested by the similarities, without being disturbed by anomalies or exceptions. The task of memory so far in marshalling and keeping hold of the instances is a very subordinate one, and may be replaced without much loss by purely mechanical means, as a black-board or paper. But, the rule having been once found and realised, memory comes in at once to grasp it and fix it indelibly on the brain. At this point the deductive process begins, according to which we learn to deal with particular cases by the general rule which we have dis-

covered; and we should not omit to practise it upon a reasonable number of instances. Here memory becomes of enormous value; for first we learn the instances, and thereby strengthen our knowledge of the rule; and next, if occasion require it, we learn other instances for daily use; for if once we have understood a process, it is unreasonable that we should be always repeating it, when we have in our minds an easier method of getting at the same result by memory. (Thus having learnt the principle of multiplication, we learn the multiplication-table, not as a substitute for, but as a supplement to, our powers of calculation.)

My conclusion then is that while children are going through the inductive process, i.e. at the beginning of a study, and of each new step in it, memory should be little called upon; in the deductive process, on the contrary, it should be in constant use.

2. On learning vocabulary.—There is another exercise of memory which I must not omit to mention, as it is the most toilsome and aggravating part of the study: I mean the learning of pages of vocabulary. This, be it observed, is not education in the strict sense; it is the supply of more or less profitable information; and I am for my own part very shy of enforcing the process where it is found utterly nauseous. The point here is to combine the maximum of advantage with the minimum of tedium; and this will best be done by 'mixing a little brains with the words,' i.e. the vocabulary should be so arranged as to bring the powers of comparison into action, though in another way.

Let us take five consecutive words from a published French vocabulary—'plume, *pen*; mère, *mother*; enfant, *child*; voici, *here is* or *here are*; père, *father*.' They happen to be the first I hit upon on opening the book, and I therefore take them the more readily as illustrating pretty well all the faults of an unscientific vocabulary. They are simply 'higgledy-piggledy,' not

even classified according to meaning, which is a faulty classification enough; and the slightest and most pardonable derangement in the apparatus of memory will make a child carry away the notion that 'plume' means *mother* and 'voici' *father*. Now to arrange them in some sort of intelligent order.

"Some French words are very easy to remember because they are the same as English words; 'plume,' English plume, which we know means *feather*, particularly a *goose-feather* or *pen*,[1] while in others the change is so slight that we can recognise them at once, as 'enfant,' English *infant*, or more generally, *child*. These we may call identical words. There are again French words which were once nearly identical with their English equivalents, but which in process of time have changed or dropped some of their radical (or root-) letters; thus, 'père,' *father*, retains the *p* (or *f*) sound, and the *r*, but has dropped the *t* sound. Similarly, 'mère,' *mother*, retains the *m* and *r*, but has dropped the *t* sound. These we may call 'metamorphic'[2] words. Finally, some words are purely French, i.e. have no resemblance to English equivalents. These may be called dissimilar words. As 'voici,' short for 'vois ci,' *see here*. But in English we don't say 'see here an apple,' we say 'here is an apple;' so we may say 'voici' means *here is* or *here are*, not forgetting however its real meaning of *see here*."

Now neither the words nor the classification chosen is perhaps the best imaginable; still, even such as they are, they illustrate fairly the difference between systematic and unsystematic vocabulary. I must observe here, however, that

[1] Note that the process of transition from 'plume' to 'pen' is insisted on, first, because it is interesting; secondly, as fairly representative of the many-sidedness of words; thirdly, to avoid the absurdity (which I find in some books) of entering 'plume' again as 'feather' a few pages later.

[2] 'Metamorphic' means 'changed in form:' a geological term invented by Sir Charles Lyell to express the alteration in the structure of rock by external influences.

my present object is not to write a scientific reading-book, but to point out the true method of teaching. But a scientific vocabulary must be either found, or constructed, if the learning it by heart is to have any result better than a parrot's chatter.

3. **Use of dictionary.**—In the more advanced stages of every language another form of vocabulary comes into use, viz., that in which students find the foreign words alphabetically arranged, with their meanings attached. This takes the place of a dictionary, though very imperfectly. I think it is as well to point out to teachers what its defects are, that they may obviate them, as far as they can, and that they may understand the advantage to themselves and to their more advanced scholars of using a dictionary. I take a sentence at random out of Cæsar's 'De Bello Gallico,' Book I.: 'Ipse in Italiam magnis itineribus contendit.' A vocabulary will probably content itself with saying, 'iter, *a journey*; contendo, *I hasten*.' Now turn to old Ainsworth and find, 'iter [ab eo, ivi, itum], (1) *a going along*, (2) *a way*, (3) *a road*... (6) *a journey*... (8) *a march*.' Now here is the whole history of the word, its derivations, with the various steps by which it arrives from the mere notion of 'going' to 'a march.' Again, 'contendo, (1) *to stretch* or *strain*... (3) *to labour* or *strive*, (4) *to march, to pursue his way in all haste*.' This is imperfect, in so far as it does not directly point to the root, 'tendo,' but otherwise the gradual development of the meaning is well brought out. It is scarcely necessary to dwell on the difference in value of the information conveyed by the two processes.

CHAPTER IV.

SUMMARY OF GENERAL RULES.

I will now summarise my observations into a few general rules.

(1) Begin your course with appropriate lessons in geography and history.
(2) Explain all technical terms as you go along.
(3) Never let a rule be learnt before its bearing has been explained by example, and understood.
(4) Put everything that has to be learnt by heart into a form that admits of classification and digestion.
(5) Where possible, prefer dictionary work to vocabulary.
(6) Look upon development of power of analysis and comparison as your object, and the knowledge of the special language will assuredly follow.

To these I would add another rule applicable to all study in these days of lectures. Let scholars do as much as possible for themselves. Remember that chewing is as im portant a process as any other in digestion; therefore give children for their intellectual food meat, cooked as well as you can cook it, but not mere sop.

CHAPTER V.

INTRODUCTORY TO SPECIAL LANGUAGES.

I propose now to go through the three subject-languages seriatim, with the view to the application of the above remarks, and with such occasional notes as are called for.

Be it noted that the arrangement which I adopt does not pretend to be scientific: a scientific arrangement can be found in any good grammar. My object is to marshal the various topics in their natural order—that, namely, in which they can be most easily taught.

Thus in French I introduce the subject of accents between regular and irregular plurals, although of course it forms part of 'pronunciation.' My reason is this: to present the whole subject of pronunciation to children *simpliciter* and in scientific order would be alike wearisome and ineffectual: therefore I begin with only so much as is absolutely necessary; and I introduce the remainder by little and little, in such a manner as to give a variety to the course, and also so as to enable the teacher to enlarge his field of illustration. So again, in Latin the verb 'esse' is introduced between the active and passive voices: for it is easier to learn the inflexions of the verb from the regular verbs; and the inflexions of 'esse' are not absolutely required until we reach the passive voice.

It is scarcely necessary to add that my treatment of each language is not intended to be in any way exhaustive. My object is to point out how to teach, not what to teach: and the sketches of lessons, &c. which will be found further on are intended solely as illustrations of methods. For this reason they are given pretty freely at the beginning of a fresh subject, and are afterwards dropped.

CHAPTER VI.

LATIN.

1. **The pronunciation.**—One of the first points to which attention is directed in some grammars is 'pronunciation.' It is a matter for the director of the study, head-teacher or otherwise, to decide what pronunciation to adopt. There is a choice of difficulties: if you adopt the old-fashioned plan of pronouncing Latin as if it were English, you will, in the present generation at any rate, be understood in England; and not understood abroad; if you adopt the Continental vowel-system, you will be less understood in England, but better abroad; if you adopt the 'new' pronunciation, your speech will be familiar to nobody in particular, but you will have the satisfaction of conforming to the newest lights. I think myself that whatever the *a priori* arguments in favour of the new or the Continental system, teachers will be safer in adopting the old English pronunciation, taking for choice that variety which broadens the long ā, as 'rosâ,' pronounce 'rosah.'

2. **Accidence. Sketch of a series of first lessons on nouns.**—I propose now to give a sketch of a set of first lessons on Latin nouns, illustrating the application of my second general rule.

You already know that there are three cases—nominative, possessive, objective: illustrate in English. 'Bill has an apple.' 'This is Bill's apple.' 'Jack struck Bill.' 'Father gave the apple to Bill.'

'Jack took the apple from Bill.' What case is 'Bill' in each of these sentences? Having elicited the names of the cases, and that the three last are all called 'objective,' go on to ask—Can you tell what case 'Bill' is in any of these by only looking at the word, without looking at its place in the sentence? Yes, where 'Bill' is in the possessive case, which we recognise by the apostrophe and 's.' Well, in some languages we can tell all the cases, one from another, by the ending of the words; and what is more, we can tell the objective case governed by a transitive verb, from that governed by the preposition 'of' or 'from.' This change of the ending for the purpose of signifying the different cases is called inflexion, or 'bending,' as if the word were bent into different shapes.

There are more names of cases in other languages than in English; we can learn them from the sentences which we have above:—'Bill has an apple.' 'Bill' is in the nominative or 'naming' case.—'This is Bill's apple.' 'Bill' is in the possessive or possessing case, because Bill possesses or owns the apple.—'Father gave the apple to Bill.' 'Bill' is here in the dative or given case; the word 'dative' comes from a Latin word 'datus,' which means *given*.—'Jack struck Bill.' 'Bill' here is in the accusative case, or what we should call the object of the action.—'Jack took the apple from Bill.' Here 'Bill' is in the ablative case: 'ablative' is from a Latin word 'ablatus,' which means *taken away*, and you will see that 'Bill' is here in the 'taken-away' case.—Now I will give you one sentence more. 'Bill! here is your apple again.' 'Bill' is here in the vocative or 'calling' case, from a Latin word 'vocatus,' meaning *called*, because by it we call Bill.

Recapitulate the cases, with their meanings, and find some other instances like them, and learn their names by heart.

Each of these cases has in Latin an ending (or termination, which means the same) of its own: for instance, if the nominative ends in -us, as servus, *a serf, a slave*, the possessive is made by putting -i instead of -us:[1] servi, *a slave's*; the dative by putting -o, as servo, *to a slave*; the accusative by putting -um, as servum, *a slave*; the vocative by putting -e, as serve, *slave!* the ablative by putting -o, as servo, *from a slave*.

Recapitulate in order, and learn by heart, 'Nominative servus, *a slave*; possessive servi, *a slave's*,' &c. Practise with similar words, as equus, *a horse*, natus, *a son*, &c. Then proceed: What number is servus, *a slave*?—Singular.—To make it plural we must change its

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[1] Don't talk, at first at least, of *changing* -us into -i; elementary school children never understand it.

shape, or inflect it again. Thus, if 'servus' means *a slave*, 'servi' means *slaves*, 'servorum,' &c. &c. Again, learn by heart and practise on other words.

3. No article expressed in Latin.—Having got thus far, the teacher had better at once relieve the children's minds of a difficulty, by explaining to them that the article is expressed in English and not in Latin. Hence of course there is an occasional ambiguity, for which they must look out.

4. Introduction of 'genitive' case.—The teacher will observe that in the above sketch I have used the familiar name 'possessive' for the second case. It will be advisable to retain the name until the children have mastered the notion of inflexion; then introduce them to the name 'genitive' as a substitute, and teach them to translate it by the use of the preposition 'of,' as well as by the strictly possessive case in English.

5. Gender.—Having now realised inflexion, as applied to case and number, we go on to gender. Here it will be necessary to pause and give a short exposition of the difference between gender as explained in English and as used in Latin, pointing out that in Latin the notion of actual male and female has been completely overwhelmed by usage, nouns being masculine, feminine, or neuter almost arbitrarily; e.g. 'a village, a city, a temple' are all neuter nouns in English, while in Latin they are respectively masculine, feminine, and neuter. Illustrate this by the arbitrary application of gender in English to words like 'ship,' 'engine,' &c. &c. Further, note the greater importance of neuter gender in Latin: in English it is almost strictly negative, i.e. little more than a recognition of the fact that the noun is neither male nor female: in Latin, it is distinctly positive i.e. it is as clearly a separate gender as if there were a third sex corresponding to it.

You are now in a position to point out that **-us** is a masculine termination (or ending); that the corresponding feminine termination is **-a**; the corresponding neuter is **-um**; as rosa, *a rose*, templum, *a temple*.

6. Inflexion of feminine and neuter nouns.—These nouns have their inflexions too. (Go through their cases as before with 'servus,' and work other examples.)

7. Declension.—So far I have said no word about declension, and purposely. I want the children to make out the idea of declensions for themselves: thus—'Do you notice that two of these words are far more like one another in their cases than either is to the third?'—Yes, 'servus' and 'templum.' Exactly; so that we might really treat them as belonging to one class, while 'rosa' belongs to another. This is in fact what we do: we say 'rosa' and all other nouns that end in *-a* and make their genitive in *-æ* are of the first class, or declension; masculine nouns in *-us*, and neuter in *-um*, making their genitive in *-i*, like 'servus' and 'templum,' are of the second class, or declension. 'Declension' is the English way of saying 'declination,' or form in which the other cases decline or seem to lean away from the nominative.—There is a diagram in some grammars illustrating this idea. Now exercise the class in declension, so far as the first and second, taking not only nominative, but oblique cases. I don't think it matters much whether you take my examples or others; my reason for selecting 'servus,' 'rosa,' and 'templum,' is that they are identical with their English equivalents; thus you do not begin by scaring children with the sight of an absolutely unknown word, and you introduce them at once and unconsciously to the all-important fact of the close relation between English and Latin.

You will now proceed to the third declension; but as the children have got into the habit of inflecting the noun, it will suffice to go straight to the case-endings, without

going through all the preparatory work given above for the first and second declensions.

You must call their attention to a striking difference between two classes of nouns in this declension, i.e. that in one class the oblique cases have the same number of syllables as the nominative, and in the other they have more: nouns of the first class are called parisyllabic, or equal-syllabled; nouns of the second class are called imparisyllabic, or not equal-syllabled. The children must now learn by heart some nouns of this declension: such as 'nubes,' 'felis,' 'rete,' 'dux,' 'terror,' 'imago,' 'corpus.' Call attention to the fact that in this, as in the previous and all other declensions, the nominative, accusative, and vocative of neuter nouns is the same. Also dwell very strongly on the fact that however unlike the nouns may be in their nominative cases, the actual endings of the oblique cases are the same throughout, thus constituting the whole into one class, or declension.

It will now be useful to give them such general rules as there are for telling the gender of a noun in this declension by the ending of its nominative; e.g. that *-x* and *-o* are generally a mark of the feminine, *-us* a mark of the neuter.

Go on to the fourth declension, taking first case-endings and then learning by heart representative nouns. Note that as a general rule all nouns ending in *-us* in this declension are masculine, and all ending in *-u* are neuter.

Then to the fifth declension in the same manner: note that all nouns in this declension are feminine.

8. Recapitulation of declensions, and exceptions.—Having got to the end of the nouns, recapitulate, noting that numerous as the nouns are in Latin, they all without exception come into one of these five classes or declensions. Now recapitulate declensions for the purpose of putting in exceptions; e.g. there are a few nouns of the first declension

ending in *-a* which are masculine, as nauta, *a sailor*; poeta, *a poet.* There are some nouns ending in *-er*, which belong to the second declension, declined as if they ended in *-rus*, as puer, *a boy*, aper, *a boar.* Moreover, nouns ending in *-us*, though generally masculine, are not invariably so; there are a few feminine and neuter, as 'humus,' 'pirus,' 'pelagus.'

9. Expansion of primary meaning of case-names.—Remember to explain to the children, before they are puzzled with it, that the meanings of the cases of nouns are not confined to those signified by their names; e.g. ablative is not always 'taken-away' case, but also expresses instrument, place, &c.

CHAPTER VII.

THE ADJECTIVE.

The foregoing sketch is intended to serve as an illustration of the method which I would advise you to adopt. If my readers have understood me, and their subject, they will see how to go on in the same way to the adjective. If they have not, I would rather not attempt to supply their deficiencies; for it cannot be too often repeated, teaching means using your own brains, not another person's; and no method can be invented which will dispense with them.

1. Reason for inflexion of adjective must be explained. (This involves the second concord.)—It will be well, however, to point out that children coming from English to Latin have at first not the faintest notion of the rule of concord that the adjective agrees with its noun in gender, number, and case; and that until this fact has been explained to them, they will be puzzled to know why adjectives are inflected at all.

I would therefore proceed to explain it somewhat as follows:—

The first striking difference that we noticed between Latin and English was that in Latin the nouns themselves told us by their endings of what gender, number, and case they were. The next striking difference is that the adjective tells us the same and in the same way. Why is this? Or how can an adjective, for instance 'beautiful,' have a gender, number, and case? Well, it cannot by itself; but remember what the meaning of 'adjective' is; it means a word added to or put along-

side of a noun to express some quality of that noun. Now that noun must have a gender, number, and case, and it is only right that the adjective joined to it should make itself as like the noun as it can. You have seen perhaps how soldiers wear a red coat because red is the Queen's colour; they wear it to show that they belong to the Queen. In the same way the adjective puts on the shape of the noun to which it is joined to show that it belongs to it. This is expressed by the following rule: 'Adjectives agree with their nouns in gender, number, and case.' Learn this by heart.

2. As to choice of examples for inflexion.—In illustrating nouns and adjectives it would be well to make some use of words which have already come before the children in the course of previous lessons; e.g. decline casus, *a case*, as a noun of the fourth declension; 'datus' and 'ablatus,' the roots of 'dative' and 'ablative,' as adjectives of three terminations.

CHAPTER VIII.

THE VERB.

1. The accidence of the verb forms the most important branch in the study of Latin. Children have now to realise—what in English grammar is terribly slurred over—the meaning of tense, mood, &c. They have to analyse their notions of past time into imperfect, perfect, and pluperfect, or whatever may be the terms used—to analyse the conditions or modes of action, so as to distinguish between indicative and subjunctive moods—to recognise the inversion of thought involved in the existence of a passive voice. It is scarcely necessary to point out that this cannot be done by simply learning tenses, &c.; the ideas must be gradually developed from the stem upwards.

Begin then at once with 'amo,' and go through the present indicative on the black-board, dwelling strongly on the fact that the changes affect the ending only, leaving a part which is never disturbed; when the children have grasped the idea, supply them with the word 'stem' to express this undisturbed part. Next, to what do these changes correspond? To changes in the person and in the number of the nominative. Hence bring out a general rule that the termination of the verb varies as the person and number of its nominative. Let this be mastered by means of the inflexions of the present indicative of 'amo' before the next step is taken.

Now proceed straight to the past tenses, first the imperfect, am-abam, *I was loving*; next the perfect, am-avi, *I*

loved; lastly, the pluperfect, am-averam, *I had loved*; learning by heart the persons as before.

2. The tenses.—When they have got over this much, it will be necessary to go back in order to rectify and explain. (I put the explanatory process second here, as the children will scarcely comprehend the explanation without having in their minds the actual tenses to which to apply it.) First discuss the present tense and bring out the fact that there is a present, in which the state of the action is left undefined, as, 'I love,' 'I eat'; next, an incomplete present, in which the action is still going on, as 'I am loving,' 'I am eating'; lastly, a present in which the action is *complete* and over, as 'I have loved,' 'I have eaten.' Now for the word 'complete' substitute 'perfect'; dwelling here on the etymology, so that the children may understand that 'perfect' does not in grammar bear its secondary sense of 'flawless,' but its primary sense of 'done thoroughly, completed.' We have then three presents—indefinite, imperfect, and perfect. To these correspond three pasts—indefinite, imperfect, and perfect.

Now in Latin the present indefinite and present imperfect are expressed in one tense, which is generally called the present; thus 'amo' means *I love*, and *I am loving*; the present perfect and past indefinite are expressed by one tense which we call the perfect tense, amavi, *I have loved*, or *I loved*; the past imperfect has a tense to itself called the imperfect, amabam, *I was loving*; the past perfect also a tense to itself, which we call the pluperfect, amaveram, *I had loved.* (You may point out that there is nothing really paradoxical in the expression of present perfect and past indefinite by the same tense, as the present perfect, though expressed in terms of the present, refers to a completed and therefore past action.)

This should be well worked out by a diagram on the black-board.

I attach considerable importance to the proper working out of this view, as without it children will always be in a mist as to the exact relations of the tenses, especially in the passive voice.

3. The subjunctive mood.—No difficulty now presents itself until we reach the subjunctive mood. The older grammars are doubtless correct in speaking of 'subjunctive or potential mood'; and it would be well that teachers should understand the difference between the two; i.e. that the subjunctive is strictly the mood of the protasis, the potential of the apodosis.[1] '*If he loved me, I would endure anything*; si me amaret (subjunctive) omnia ferrem' (potential). I do not, however, think it advisable to perplex children with such delicate distinctions. Let it suffice to say, the subjunctive mood is that form which the verb assumes when subjoined to another to express purpose or condition, &c. (i.e. in certain subordinate sentences); as, 'I ran, that I might obtain the prize;' 'he punished him lest he should do it again;' 'I would give it, if I had it;' 'it is doubtful whether the planets are inhabited.' This will be enough to give children some notion of what they are learning; when they have committed the tenses of the subjunctive to memory, they may be told that the same forms are used in a principal sentence to express uncertainty or possibility, so that in the sentence 'I would give it, if I had it,' both verbs are in the subjunctive mood.

4. The active participles.— On the participle point out that there is in Latin only a present and a future participle: dwell on the absence of a perfect participle.

[1] Roughly speaking, the protasis and apodosis are the subordinate and principal parts respectively of a complex sentence: but teachers to whom these terms present a difficulty, should accept the fact as a warning that they have not done much more than 'pick up pebbles on the shore' of grammar.

5. The conjugations. — Having completed the tenses of the active voice of 'amo,' recapitulate with other illustrations and much black-board work, to bring out forcibly the characteristic *a*, and inform the children that verbs inflected with this characteristic *a* are called verbs of the first conjugation.

The remaining conjugations want little more than committing to memory; but black-board lessons should be given with each, to bring out its characteristic, whether vowel or consonant.

Be careful that in the third conjugation the children do not lose sight of the root in such forms as 'rego,' 'rexi' (reg-si).

6. Formation of simple sentences. (First appearance of composition.)—All these lessons should be varied and enlivened from time to time by translation lessons, from Latin to English and *vice versâ*, the teacher supplying the words where wanted. In these lessons keep to regular verbs in the active voice, but do not scruple to anticipate rules of syntax, such as the government of nouns by verbs and prepositions, and the sequence of tenses in subordinate sentences of purpose and condition. A vast amount of simple syntax will be picked up unconsciously in this way out of such sentences as 'date obolum Belisario,' 'miles faciem ense ferit,' &c. (Observe that although 'dare' is irregular in the perfect, I do not discard its regular tenses. Next observe that my two examples above will bear talking about; each is connected with a story in Roman history, which will interest children, and fix the words in their memories.)

7. 'Esse.'—It is now time to take up the verb 'esse.' We have left it out hitherto, on account of its great irregularity; but as by this time the children ought to have got hold of the structure of the verb tolerably well, and as the

passive voice cannot be properly worked without it, it should now be learnt. At the same time it should be carefully pointed out that this verb is utterly irregular, being in fact a mosaic made up of parts of several verbs, of each of which the remainder is lost. Again practise translation and composition, making use of the different forms of the newly-acquired word; and let the children notice incidentally that in Latin, as in English, the verb 'to be' has the same case after it as before it.

8. The passive voice.—The passive voice appears to present great difficulties to tiros in English grammar, principally, I suspect, from an inability to distinguish between the uses of the verb 'to be' as a copula and as an auxiliary. It must be confessed that in such phrases as 'I am cold,' 'I am frozen,' 'I am being frozen,' it is difficult to mark the precise point where 'am' ceases to be a copula, and becomes an auxiliary, although there is no doubt as to its status in the first and last of the three. In Latin the same difficulty presents itself to a certain extent, but it may be got over by carefully adhering to the division of present and past tenses, which was given above, under the head of the active voice.

First, then, get the children to invert a simple sentence or two, as 'the dog bites the man;' 'the man strikes the dog;' i.e. get them to express the same idea, but with the object of the old sentence used as subject of the new: 'the man is bitten by the dog,' &c. Do the same with past and future tenses: 'the dog bit the man,' 'the dog will bite the man,' &c. This inverted form of the verb, whereby its subject is made to suffer the action, instead of doing it, is called its passive voice. It is formed in Latin by inflexion, thus: 'Am-o, *I am loving*,' becomes 'am-or, *I am being loved*.' 'Am-o, *I love*' . . . 'am-atus sum, *I am loved*.' 'Am-atus, *having been loved*,' or more shortly '*loved*,' is the perfect participle of the passive voice.

9. Tenses of passive voice.—The present indefinite (p. 26, § 2, *supra*) is formed by this perfect participle, with the auxiliary 'sum,' 'amatus sum, *I am loved.*' (Note the exact coincidence with English.)[1] The present imperfect is that mentioned above, 'amor, *I am being loved*;' the present perfect is formed by the perfect participle with the present perfect of 'sum,' 'amatus fui, *I have been loved.*' Their respective past tenses are, 'amatus eram,' 'amabar,' and 'amatus fueram.'

In learning the verb, however, the indefinite and perfect tenses, both past and present, are taken together (partly from the similarity of their construction, and partly from a tendency of their meanings in this passive voice to slip into and coincide with one another). We therefore talk of 'amor, *I am being loved*,' present passive; 'amabar, *I was being loved*,' imperfect passive; 'amatus sum *or* fui, *I am* or *have been loved*,' perfect passive; 'amatus eram *or* fueram, *I was* or *had been loved*,' pluperfect passive.

10. The participle with auxiliary is inflected in gender and number.—In learning these tenses, be careful to point out that the perfect participle, when thus used with an auxiliary, does not in any way lose its characteristic as a participle of being partly an adjective, and therefore, according to the rule found above (p. 24, ch. vii. § 1), must agree with its noun (or pronoun) in number, and gender, and case. It may therefore be 'amatus,' 'amata,' or 'amatum sum;' 'amati,' 'amatæ,' or 'amata sumus.'

[1] To illustrate the value of presenting the tense in this manner to children, take the first sentence in Cæsar *de Bello Gallico*: 'Gallia est omnis divisa in partes tres.' If children are taught that 'divisus sum' is a perfect, they will translate this 'has been divided,' contrary to the sense; and when taught to say 'is divided,' will conclude that 'est' is here a copula, not an auxiliary.

CHAPTER IX.

CONCLUSION OF ACCIDENCE.

I have now touched upon all the points in the accidence which appear to me to call for remark, and I have suggested methods of dealing with the difficulties. If the spirit of these be carefully followed out, the children will have little trouble with the remainder; and it is to be hoped that the consciousness of having mastered thus much will make the inevitable grind at learning by heart less irksome, because more hopeful. The irregular verbs can only be learnt; the classification of them in the 'Public School Grammar' may well be adopted. If teachers like, they may try the effect of impressing them on the mind by a metrical jingle;[1] but the results are not very trustworthy.

Deponent and anomalous and defective verbs offer no

[1] Metrical jingles often impress single facts, but are equally often dangerous. Thus—

> 'In nemo you will never see
> Neminis or nemine,'

is useful. On the other hand, we read—

> 'Verbal nouns in *-io* call
> Feminina, one and all;
> Mascula will only be
> Things that you may touch or see
> (As curculio, vespertilio,
> Pugio, scipio, and papilio).'

Let the two middle lines slip out, and the lines, while making equally good sense, are all wrong.

special difficulty; nor do pronouns, adverbs, and conjunctions require particular explanation.

In dealing with the pronouns, however, especially the relative, it will be necessary to give much practice in sentences illustrating the various cases, and specially with reference to the agreement of the relative with its antecedent.

CHAPTER X.

SYNTAX.

1. **The four concords.**—Of the four concords three will have been already practically disposed of—the agreement of the verb with its nominative, of the adjective with its noun, of the relative with its antecedent. It only remains to state them specifically, and to dwell on the enlargement of the first concord. The old rule that the first person is more worthy than the second, &c., is almost worth preservation as a survival of scholastic quaintness: but it should be explained on a more scientific principle, thus:—

In the sentence 'we took a walk,' what does 'we' mean? It means 'I and you,' or 'I and one or more besides.' 'I and you' or 'I and one or more besides' are equivalent to 'we'; therefore they require a verb in the first person plural; and generally—

> 'Where the pronoun of the first person forms part of a compound nominative, the verb shall be in the first person plural.'
>
> Similarly 'ye' means 'you and one or more besides,' &c.

The third concord, of the noun in apposition with its principal, should be treated as an extension of the concord of the adjective with its noun, by showing that the noun in apposition is, in fact, like an adjective, a qualifying word.

2. **Learn syntax by language, not language by syntax.**—I have now arrived at the point where, I fear, I

shall part company with the majority of teachers of grammar. I would entirely invert the old process of teaching; and, instead of giving abstract rules first, and illustrating them by examples afterwards, I would give a sufficient number of apt examples first, lead the children to see the feature common to them all, and hence to make the rule for themselves. I will only repeat and condense my reason: first, it is the natural and historical method by which grammatical rules were first invented; secondly, it fosters the habit of generalisation; thirdly, it keeps the teacher and the class in continual mental contact.

3. Difference between rules of concord and rules of syntax.—It may be asked, why not apply this method earlier, and teach the four concords thus? I will answer this question at length, for the benefit of younger readers who may thus be led to understand better the real nature and authority of syntactical rules.

A rule of syntax in the strictest and best sense is a simple generalisation, i.e. an expression in general terms of a phenomenon which we find invariably recurring where the circumstances are similar. Thus, we find the object after the verb 'amo' is put in the accusative case; the same after 'occido'; the same after 'ferio'; the same after 'rego,' &c. We inquire what common feature these words have, and we find they are all transitive verbs. Hence we say in general terms, 'a transitive verb is followed by its object in the accusative case.' This power of seeing a general rule in a number of particular instances is a peculiar faculty of the intelligence: but it must be carefully borne in mind that the validity of such a general rule depends solely on the number of instances in its favour and the absence of instances to the contrary, and not at all on any quality of the words themselves. To put the matter in another way, if a stranger were given the six cases of the noun 'pater,' and were asked which of them must follow the transitive verb 'amo,' the chances would be

five to one against his naming the accusative, as there is nothing in the word 'patrem' itself to lead him to a right conclusion.

The idea of the concords, on the other hand, as I have attempted to show above, is inherent in the idea of inflexion; they exist by virtue, and only by virtue, of the inflexions. Thus we say 'the adjective agrees with its noun in gender, number, and case,' simply because the adjective has the power of inflecting itself into the same shape as the noun in those respects. A fair negative proof of the soundness of this view is that in English grammar where adjectives are not inflected, no such concord is taught.[1]

A rule of concord, therefore, is only an expression of a quality existing in words by virtue of their capacity for inflexion. A rule of syntax is a description of the modification which words undergo in certain relations with other words, according to the invariable custom of the language.

4. Choice of instances whereby to teach syntax. It will, however, be urged that examples sufficient in nature and in number for the formation of a rule must be either made or found, either alternative assuming a familiarity with the language not common in Elementary School Staff. The objection is, no doubt, a weighty one, but I should be loth to think that elementary school children have therefore no choice but to go in for the repulsive drudgery involved in learning rules in the old fashion.

There is another process by which a knowledge of rules may be obtained, not equally scientific perhaps, but far more interesting to young scholars. Those familiar with such matters will readily recognise the source from which I partly borrow it.

[1] Does not concord then exist in the nominative of adjectives of one termination, as 'felix,' or in the case of an indeclinable adjective, as 'nequam'? Strictly, perhaps, it does not; but for the sake of uniformity we make believe that it is there, treating the inflexion as latent.

5. Sketch of a first lesson. Meaning.—Go at once to your Cæsar 'de Bello Gallico.' Take a sentence, the very first in the book if you like, and treat it thus—

Write on black-board, 'Gallia est omnis divisa in partes tres, quarum unam incolunt Belgæ, aliam Aquitani, tertiam qui ipsorum lingua Celtæ, nostra Galli appellantur.' Translate literally:—'Gaul is all divided into parts three, of which one inhabit the Belgæ, another the Aquitani, a third who of themselves the language Celtæ, ours Galli are called.' So far we have little or no sense: let us see whether a little thought and the application of our accidence will not help us out. 'Parts three'—what does that stand for, do you think? 'Three parts,' certainly. Notice, then, that in Latin the adjective can be put after the noun. So far, then, we can understand: 'Gaul is all divided into three parts.'

Now, 'of which one inhabit the Belgæ.' What case is 'unam'? Accusative. What part of the verb is 'incolunt'? Third person plural present. What case is 'Belgæ'? Either genitive or dative singular, or nominative plural. Now, seeing that 'incolunt' is in the third person plural, what must its nominative be? Also third person plural. This fixes our choice as to the *case* of Belgæ. Now, in English where do we put the nominative? Before the verb. Then let us say, 'of which one the Belgæ inhabit.' (Notice, then, that in Latin the nominative may be found after the verb.)

Now, what sort of a verb is 'inhabit'? Transitive. What is its object here? One. But 'one' is a numeral adjective: what do adjectives do? Qualify and agree with nouns. What noun does 'one' qualify and agree with? Clearly none expressed: can we find one not expressed? We spoke just now of three parts: now we speak of one——? Part. Then 'part' understood is the object. Where do we generally put the object in English? After the verb. Do so here, and we get 'of which the Belgæ inhabit one part.'

Now, 'another the Aquitani'—surely we want a verb

here. The scholars will be pretty ready to supply the verb 'inhabit'; and (proceeding as before) we get 'the Aquitani inhabit another.'

Now, 'a third who of themselves the language Celtæ, ours Gauls, are called.' I must help you here. The meaning is, 'They who are called Celtæ in their own language, in our language Galli, inhabit the third part.' Let us see how we get that meaning out of the words. First we see that, as before, the adjective with its noun understood, which forms the object, has come first in Latin; next that, as before, the verb, being the same as in the previous clause, is understood. Next we find that the word 'they' has been introduced to form the antecedent to 'qui,' *who.* We shall often find the antecedent left out where it is a pronoun. Then we notice that the number of 'qui,' which is in itself ambiguous, is determined by the plural termination of the verb. About the word 'Celtæ' we need only observe that in the Latin it has been placed before the verb, whereas in English we must place it after the verb. Now, how do we get 'in their own language'? These words stand for 'ipsorum lingua.' 'Lingua,' I must tell you, is here in the ablative case; the ablative case is often used to express the manner in which a thing is done. 'Ipsorum' is what? A genitive plural, which we have learnt among the pronouns, from 'ipse,' meaning *himself*; therefore 'ipsorum,' *of themselves*, and so we get 'of themselves in the language.' We have already noticed that words are not arranged always in Latin as in English: let us invert these, and we get 'in the language of themselves.' This is the exact meaning, but it sounds prettier in English to say—what means the same—'in their own language.'

Now 'nostra.' We have learnt this; it is a part of 'noster,' *our*, a possessive adjective-pronoun, and it qualifies a noun understood, 'lingua,' supplied from the previous clause: let us therefore express the word as before, and we get 'in our language Galli.'

Now recapitulate : 'Gaul is all divided into three parts, of which the Belgæ inhabit one part, the Aquitani inhabit another part, they who are called Celtæ in their own language, Galli in our language, inhabit a third part.'

Here in strictness a first lesson should break off, but if I noticed any hesitation in the scholars' minds in realising that the sentence thus translated had a meaning, and what that meaning was, I would arouse them by pretending to read about Great Britain, that 'it is divided into three parts, of which the English inhabit one part, the Scotch another, they who are called Cymri in their own language, Welsh in our language, inhabit a third.' I should also, either at the close of the lesson, or at the beginning of the next, produce a map of old Gaul to illustrate the statement.

6. Sketch of second lesson. Grammar.—In the next lesson the same passage should be parsed ; the nature of each word should be stated, its primary form if it is inflected, and any rule of concord which affected it, should be referred to. Rules of grammar not being known, they will not be cited, but the mere facts should be stated ; e.g. 'partes,' accusative following the preposition 'in,' meaning 'into' ; 'unam' (partem), accusative after a transitive verb 'incolunt' ; 'lingua,' ablative, expressing the manner ; 'Celtæ,' nominative after 'appellantur.' (In the last case it will be advisable to ask as to any verb in English which allows a nominative to follow it, and thus foreshadow the rule to be eventually laid down here.)

7. Sketch of third lesson. Composition.—The third lesson here is one which requires a ready teacher. It consists of taking the words of the sentence and reforming them into fresh sentences, first very simple and gradually increasing in complexity, and finally introducing other but simple inflexions of the words used ; e.g.

'The Belgæ inhabit Gaul'; 'they who are called Aquitani inhabit Gaul'; 'the Celtæ are divided into three parts'; 'they who inhabit one part of Gaul are called Belgæ'; 'Cæsar divides Gaul into three parts'; 'the language of Gaul is divided'; 'all the Belgæ used to inhabit (imperfect) Gaul,' &c.

8. Results of lessons above.—Having exhausted this sentence, select another of a simple character, and treat it in the same way; and in the course of a very short time you will have familiarised the scholars with such rules as that 'the subject of a finite verb is in the nominative case,' 'a transitive verb requires an object in the accusative case,' 'verbs of being with their cognates take the nominative case after them where the nominative precedes them.' (N.B. Be satisfied with this restricted form of this rule at first; the more extended rule that they take the same case after them as before them can only be understood when the children actually come across an oblique case before these verbs, as in the accusative and infinitive.)

The ablative of 'instrument and manner and of place,' of 'time when,' the accusative of 'motion to' and of 'time how long,' should be worked in the same way. The rules as to the dative require very special work, being in fact singularly arbitrary. It would be well to begin with the government by verbs of 'giving,' as this may be connected with the etymology of the word 'dative,' as shown above, and hence to work onwards to the general relation which this case expresses.

The next step will be to the syntax of dependent clauses: the first and simplest is that of the ablative after the comparative, then comes the accusative with infinitive, the ablative absolute and the gerundive participle.

Lastly comes the syntax of subordinate sentences, and thus the subjunctive mood.

A ready teacher who knows his subject will have no

difficulty in finding or framing apt sentences out of the first book of Cæsar for the introduction and inculcation of all these points, and he will find, as the lessons advance, that less and less help in translation will be required; the children, as they get accustomed to the method, will soon be dissatisfied with the mere literal meanings of the words and will ferret out the meaning of the sentence for themselves. When this stage is arrived at, the vocabulary should be introduced; after which time they may be left far more to themselves. The use of the dictionary is the last step; on the importance and value of it I have touched above; at the same time it is distinctly the last step, and one which will probably not be reached in the elementary school.

9. Second and third years' course.—It may be asked whereabouts in the above course the line is to be drawn separating the second and the third year's work. My answer is nowhere, or anywhere. It is impossible to define exactly the extent of 'the first rules of syntax' required in the second year, but it is certain that by the above method they will have been amply covered; at the same time, a larger stock of useful words will have been acquired, together with greater familiarity with the use of them, than could have been obtained by working 'delectus, or other first Latin reading-book.' Whether Cæsar is absolutely the best book for the purpose is another question; it is sufficient to say that it is good enough.

CHAPTER XI.

FRENCH.

1. Having gone at some length into the method to be adopted for teaching Latin, I need not do much more than point out that the same may be applied to French.

2. **Pronunciation.**—Thus, in teaching pronunciation, it is of no use to give general rules for the letters, in the hope that they may be applied to the particular word, but we must teach the pronunciation of particular words; and hence, if you like, make a rule for the letters. The same applies to the accents, and the 'liaison,' on which I have a word or two below. (I may remark here that, in my opinion, the compilers of the Code have erred in putting 'pronunciation' at the end of the whole course. It may be a question whether it should be taken up at the very beginning; and I can only give it as my experience that it is very nearly as easy to begin right as wrong. But to remit all mention of the matter till faults are all inveterate is preposterous.)

3. **Accidence.**—Again, the children should find out for themselves the distinctions of the genders and numbers in articles, nouns, and adjectives. Begin with some examples of the noun with the article, as 'le père,' 'la mère,' 'l'enfant.' Write these on the black-board, with translation; let the children simply follow your lead till they pronounce the words correctly, and can give their meaning; next, bring them to see that 'le,' 'la,' 'l'' must stand in each case

for *the*. Then take—say, 'l'air,' 'l'enfant,' 'l'image,' 'l'office,' 'l'uniforme;' run over the meanings, and again point out that 'l'' stands for *the*. Elicit the fact (or teach it, for it is one with which our elementary school children are seldom familiar) that these words all begin with a vowel. Then teach the meaning of the apostrophe as the mark of elision, and so get to the rule that 'le' or 'la' stands for *the*, having dropped their vowel before a following vowel in the noun. Experiment with other nouns, as 'ange,' 'or,' 'idole,' &c.

4. **Gender.**—Having mastered thus much, give a few nouns masculine and feminine (in sex as well as gender), as 'le père,' 'la mère,' 'le cheval,' 'la jument,' 'le bœuf,' 'la vache,' with their meanings; and get the children to find out that the difference between 'le' and 'la' depends on gender. You will now explain to them, as above (p. 19, chap. vi. § 5), that, in French, sex and gender are not connected, and illustrate the fact. Let them learn a few of the illustrations, as 'le ciel,' 'la mer,' 'la terre,' 'le soleil,' 'la lune,' 'le lait,' 'la table,' 'la quille,' 'le quartier.' (Note the two last examples, which will bring in incidentally the fact that 'qu' has generally only the sound of 'k' in French. The exceptions to this rule are not likely to be met with.)

5. **Number: regular plurals.**—As there are really no cases to French nouns, you will now proceed to the plural number, as regularly formed by adding *s*, and let the children note the similarity to the English rule: use the former examples where practicable. In the plural of words beginning with a vowel, teach them to sound the 'liaison' with the article, and illustrate the idea of euphony on which it depends.

6. **Accents.**—Now take two words, like 'pêche' and 'péché,' and bring out by their means the function of accents

and their use in 'differentiating' words. Gradually enlarge the scope of the lesson until it takes in all the accents, with apt illustrations, as 'cité,' 'tête,' 'remède,' 'été,' 'quête,' 'modèle.' (Note that every new word learnt should have its proper definite article attached, as in the lesson on the articles. Finally, form their plurals as before.)

7. **Irregular plurals.**—The irregularities in the formation of the plural may now be taught, but very generally: the children will pick up enough at first by ear; when they begin to catch the principle, let them learn the rules as to the exceptional plurals by heart.

8. **The adjective and its inflexions.**—Now proceed to the inflexions of the indefinite article and the adjective, following the lines laid down above, under the head of Latin Adjectives (p. 23, ch. vii. § 1). The rules for the formation of the feminine will best be learnt by ear at first, and reduced into cut-and-dried shape later. Irregular formations had better be omitted, except in the case of such necessary words as 'bon,' 'beau,' 'doux,' 'long,' 'vieux,' and two or three others.

9. **Begin composition.**—You have now sufficient grammar to make small but intelligible sentences, composed of noun, copula, and adjective. From these proceed to similar sentences, with extension by means of a prepositional phrase. Thus (1) 'le lait est doux,' 'la crème est blanche,' 'l'encre est noire;' (2) 'le lait est dans la tasse,' 'la crème est sur la table,' 'l'encre est dans l'encrier.' Let the prepositions and their uses be thus learnt by ear rather than by rule. Now proceed to the use of 'de' (1) simply, (2) compounded into 'du'; and thus enlarge your sentences by the introduction of genitive cases; next treat 'à' and 'au' in the same manner.

10. **The verbs 'être' and 'avoir.'**—In learning the French verb, it is unfortunately necessary to begin with the

irregular 'être' and 'avoir,' inasmuch as they enter so largely as auxiliaries into the formation of the regular verbs. Here, as in Latin, a good deal of trouble should be taken (more certainly than seems to be expected in the published grammars) to enable the children to realise the meaning of the tenses.[1] It is unfortunate that the nomenclature here is more than usually difficult; past definite and anterior (or worse still, preterite definite and anterior) being enough to daze the brightest intellect of the elementary school. I should, however, recommend that, in first going through 'avoir' and 'être,' none but the simple tenses be learned; i.e. those required as auxiliaries in the compound tenses of other verbs.

In the moods the conditional will be a new name to the children, but will not be difficult to explain.

In the course of learning their first verb the children will also have learned incidentally the nominative cases of the personal pronouns.

II. Conjugations.—From this point onwards through the conjugations of the regular verbs I have no recommendation to make except this, that each of the examples should be illustrated at once by a sentence, and also by similar formations of other verbs; thus, when the children have learnt the imperfect, 'j'aimais, *I was loving*,' let them, before going on, (1) frame sentences, such as 'le père aimait l'enfant,' 'tu aimais le lait,' 'les enfants aimaient la mère,' and (2) learn to conjugate other verbs, as, 'j'apportais,' 'je frappais,' &c., and frame sentences therewith. This will afford a useful exercise of wits for both teacher and scholars.

[1] For a sketch of the relation between present and past tenses, see p. 26, ch. viii. § 2; but note that the present imperfect active ('I am striking') is rarely expressed by the French present active; the present imperfect passive ('I am being struck') is never expressed by the French present passive. A periphrasis is required instead.

12. Pronouns.—The next step after the verb will be the inflexion of the pronouns: here children will be easily led to recognise the similarity to the English language, in which also pronouns are the only words inflected as to case.

Along with the demonstrative you may point out the valuable indefinite 'on,' and the two solitary neuter forms 'ceci' and 'cela,' as in constant use.

13. Miscellaneous.—I pass over several small but by no means unnecessary details, as the proper use of the negative 'ne ... pas,' the construction of interrogatory sentences, &c. These will be readily enough learnt by ear and practice; but in these, as in all other cases, let the children hear the expression in actual use before it is made the subject of a rule.

14. Vocabulary.—We now come to the difficult question of vocabulary, on which I have already made some comments. The difficulty is, first, to say what the Code means, and, secondly, to work out the interpretation of it. 'Vocabulary' primarily means a book of vocables or words; but it is hard to believe that children were intended to learn dry lists of words, the most dreary and at the same time the most useless task in which they could be engaged. True, it may be vitalised to a certain extent by arranging the words on some system, as I have pointed out above; but the question remains to be answered, where such a 'catalogue raisonné' is to be found. On the other hand, it is clear that the Code requires something to be learnt over and above 'avoir,' 'être,' 'aimer,' &c. Probably what is meant is that the children should get in a small stock of words equal in bulk to ten pages of a vocabulary; it behoves us, therefore, to see how this may best be done.

For my part, I should recommend teachers either to work their vocabulary into the lessons in the shape of

examples of the various rules, in the manner suggested in the previous sections of this chapter, or to set a very easy and short story to be learned by heart, and then to be picked to pieces and reconstructed into short sentences, as suggested above, under Latin Syntax (p. 36, ch. x. § 5).

15. Second and third years' course.—The second and third years' courses must begin with the irregular verbs, on which all the advice I can give is to go through them, but not to learn them by heart; the time required would be too long, and the results disproportionate: the irregular verbs are learnt by use and by reference; but they must be read through in order that the children may know their way about them when reference is necessary.

16. Grammar for second and third years.—The Code here lays down, rather vaguely, 'grammar' as part of the requirement, leaving it uncertain whether the teacher should take a portion in the second year and the remainder in the third, or treat the whole in each year, lightly in the second year, and more completely in the third. Taking this uncertainty into consideration, as well as my own experience of the difficulty of dealing with the subject satisfactorily in this manner and in the time allowed, I would take the responsibility of bidding the teacher proceed boldly into a reading-book, as simple as may be, but interesting and connected. The book may be submitted to the Inspector for approval, with a query whether he will be satisfied with a general knowledge of the meaning of, say, twenty pages of it, with a power of reproducing it in conversation, and a general knowledge of the rules of grammar involved.

17. Reading-book.—For instance, take Erckmann-Chatrian's 'Waterloo,' chap. xviii., The Battle of Ligny. The first page presents very few difficulties, and those of a very

simple character; such are, 'je m'éveillais,' reflective verb, translated in English by a simple verb—'à la lune, *in the moonlight*'—'des Qui vive, *cries of* Qui vive'—'se voyaient, *saw each other*'—'à deux cents pas, *at* (a distance of) 200 *paces*'—'me levais,' compare with 'm'éveillais' above—'il faisait du vent,' idiomatic impersonal use of a verb—'il tombait une goutte,' not so easy of explanation, but illustrating the occasional idiomatic use of 'il' as grammatical subject, where the logical subject follows, an idiom not common enough to require more than passing attention.

I should begin by reading to the children the first sentence. I should then translate it, first literally, then (by the help of the children) grammatically (see above, pp. 36–38, ch. x. §§ 5, 6), then read it again, making them follow simultaneously; then read off the literal meanings; then the grammatical. By this time they will have picked up most of the words by heart. Some exercises from English into French would now be advisable, but this is not at present necessary, and you may pass at once to the next sentence, and treat it in the same way. Recapitulate the back lesson summarily at the beginning of the next. Where any point has appeared peculiarly knotty, mark it in the book and recapitulate it summarily at the beginning of every lesson, until it is grasped.

18. Composition. — These lessons advance rather slowly at first, but it is surprising how soon they begin to gain in speed; and it will be found that there will be time for evolving the grammatical rules, and also for turning English into French. This, which, as I said above, may be begun at once, should at any rate not be delayed beyond the time when the children get used to the method. It should be oral entirely at first; but the children should be encouraged to write on their slates the sentences they compose. (As to use of vocabulary and dictionary, see pp. 39–40, ch. x. § 8.)

CHAPTER XII.

GERMAN.

1. Difficulties peculiar to study of German.—I do not believe it to be possible to effect anything practical in teaching German in an elementary school. The difficulties are singular: first comes the character; second, the pronunciation; then the multitude of ambiguous sounds used in inflexion; for example, the termination *en*, a jack-of-all-trades, used for well-nigh everything, from a present infinitive to a dative plural: then the minute and apparently arbitrary inflexions of the noun and adjective; the wilderness of auxiliaries required for the verb, and the fact that familiar English auxiliaries (be, will, should) are not auxiliaries in German; the pedantic rules as to position of the verb; the existence of separable verbs; and above all, the difficulty of finding a book which will not either disgust children by its childishness, or repel them by its crabbedness. It will be said, and with truth, that in the copious ballads or poems in ballad-form of the German school we may find much of pellucid, almost infantine, simplicity; but the difficulty still remains of bridging over the wide interval between such works and the ordinary German prose. For these reasons I cannot hold out a hope of doing much with German within the time applicable thereto.

2. Résumé of method.—If the attempt is made, the method had better be a combination of those laid down above for Latin and French; i.e. first learn a few easy nouns

with their definite articles, and their meanings: hence work out distinctions of gender and number. The declension of nouns will follow, with explanation of the use of cases as in Latin; next the indefinite article, adjective, pronoun, with their inflexions. Then form sentences with noun, copula ('ist' or 'sind'), and adjective or pronoun, or such prepositional phrase as can be used. Here must be learnt the very intricate rules for the inflexion of the adjective (1) alone, (2) preceded by the definite article, (3) preceded by the indefinite article, &c. Practice and ear, here as elsewhere, will be required to supplement the rule, which is really of a somewhat arbitrary character.

3. **Auxiliaries.**—Before the verb can be discussed, a thorough and searching lesson is required in the use and function of English auxiliaries.

It may be asked, why this is required in the study of German rather than in that of French. The reason is, that the French auxiliaries follow so closely the lines of the English, both in nature, use, and position, that the English mind can adopt and assimilate them without positive explanation, salutary as that would be, if time allowed it. Thus, 'ils avaient été frappés' is the literal translation of 'they had been struck,' word by word, while 'nous aurons été frappés' only requires the simple amplification of 'aurons' into 'shall have.' On the other hand, the German auxiliary is often either different in nature and use, as in 'Ich *werde* geschlagen, *I am being struck*'; or 'Ich *werde* schlagen, *I shall strike*'; or in position, as where it follows the participle, as in 'Ich werde geschlagen worden sein, *I shall have been struck*.'

If, therefore, you hope to get children to learn their tenses intelligently, you must first see that they understand the principle of auxiliaries; and you must be continuously on your guard later on, lest they try to translate English auxiliaries by their German homonyms instead of their

German equivalents, and thereby produce barbarisms, such as 'Ich will gehen, *I will go*'; 'Er ist von einem Kind geleitet, *He is (being) led by a child.*'

4. **The verb.**—It will be necessary to learn *werden*, *sein*, and *haben* by heart, in order to get the needful inflexions of those auxiliaries, before attacking the regular verbs. Apart from the question of the auxiliaries, the verb presents another difficulty, in the fact that while the simple past tense resembles the English in form, it often differs from it in sense.

5. **Composition.**—The regular verb presents no other difficulties; and when children have been brought thus far, they should have had their minds stored with a sufficient number of nouns, adjectives, prepositions, and pronouns to make the composition and decomposition of simple sentences pretty easy. As to vocabulary, I can only repeat what I said above (p. 45, ch. xi. § 14).

6. **Irregular verbs.**—The irregular verbs are not, on the whole, so hard as they look; for this reason, that English is here a real help. Thus you would first bring out the similarity between two regular verbs in German and English, a similarity which consists in this, that they both are inflected by addition of syllables to an unchanged stem. Hence you lead to the similarity between the irregular verbs in the two languages, which are inflected by more or less change in the stem. It may then be pointed out that, as the languages are so closely allied, there is always a presumption that an irregular verb in English is irregular also in German, as in 'rennen,' 'denken,' 'liegen,' 'thun,' 'beginnen,' &c. But, after all, there is little to be done but to learn these verbs by heart.

7. **Compound verbs.**—The rules as to the separability or otherwise of compound verbs will require to be explained

at some time or other; but it would be better to postpone them until an instance occurs.

8. Reading-books.—Inasmuch as the adverbs and conjunctions here, as in other languages, can be properly learnt by use only, I would advise a teacher at this point to shake off the dust of the grammar entirely, and go to translation of easy German, such as Hans Christian Andersen's 'Tales' (in German translation), or *selected* portions of Goethe's 'Reinecke Fuchs,' working it in the way laid down above (ch. x. § 5, p. 36; ch. xi. § 17, p. 47).

9. Second and third years.—As to the division between second and third years' course, see my remarks above (p. 46, ch. xi. § 15–17), which would apply equally here.

CHAPTER XIII.

CONCLUDING REMARKS.

1. Amount of time required for course of study. The question will naturally be asked, What length of time will be required to carry out these courses of study, assuming them to be taken as additional to the ordinary work of the elementary school? I consider that, to do the work properly, at least two hours a week are necessary, in three lessons, if possible; if not, in two; in addition to which, home lessons will be required, as soon as the children can do anything alone, either in the way of learning by heart or of writing exercises. The idea of ten-minute lessons is—an idea: I do not think any teachers are likely to try it.

2. Pupil-teacher's share in instruction.—Another important question is, What part can pupil-teachers take in instruction of this sort? My answer is, a very subordinate one. Of course, if the study of a language consisted only of grinding into the memory declensions, conjugations, rules with cut-and-dried examples, and strings of words, a pupil-teacher might superintend it pretty nearly as well as an experienced adult; but where system, foresight, and accurate knowledge of minutiæ, quickness of apprehension, and versatility of thought are the essence of the method, it is doing no injustice to pupil-teachers to say that they are generally unequal to the task. All introductory

lessons must, therefore, here as in all other studies, be given exclusively by the head-teacher. As the class advances, the pupil-teacher will find his proper function in getting a class together for the head-teacher, and in recapitulating the last preceding lesson. He may hear, with the book in his hands, anything that has been learnt by heart; he may, when the foundation of a rule has been laid, guide the class in working out further instances of it; he may look over written work before it goes into the hands of the head-teacher; he may work up backward and irregular children on the lines already laid down by the head-teacher. The assistance thus given will be of a most valuable character, and will require all the intelligence and adaptability of a good pupil-teacher. But if a pupil-teacher be dull, unready, or superficial, I can only advise that he be left to take charge of studies, if such there be, in which these qualities are no drawback. In the study of language he will only stupefy or mislead a class just where intelligence is most essential, and misconceptions are hardest of correction.

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DOMESTIC ECONOMY.

FIRST BRANCH.

CHAPTER I.

THE SUBJECT GENERALLY.

Object of Manual.—My purpose in the following pages is to offer you some hints which may prove useful in teaching classes that particular specific subject, Domestic Economy, which, as it is the most comprehensive, is also the most important, of those appointed by the Committee of Council for additional instruction in schools. (Vide New Code, Schedule 4.)

Importance of subject.—I claim for this special branch of teaching the very first rank in importance on common-sense grounds. History, Geography, French, German, Latin, are all admirable things in their way; to many children they will prove of actual value in after life, and to all they are of a certain immediate value, as tending generally to open the intellect, to store the memory, to add to the stock of knowledge. But no one of these studies, however specially useful to individuals, or generally useful to classes, can be called *essential* to our national education. This must be asserted, however, of domestic economy, and

perhaps a short reflection on what domestic economy means may help to show us why.

Meaning of domestic economy.—Economy, in its literal sense, means 'the rule of the house:' in one word, *housekeeping*. This meaning has been much perverted, so that many people think *economy* means *niggardliness*, which it does not to anyone who uses words with regard to their real meaning, as we all should do. But as this wrong meaning has become only too common, we have got into the way of distinguishing the true sense of economy by putting another word before it; and so we use the terms Domestic Economy, which really mean 'home housekeeping,' as describing the study which we here take in hand.

Its utility to all persons.—Now, we shall see the universal need of 'Domestic Economy' as compared with other studies. Many can get through life somehow without knowing French, German, Latin, Algebra, or Physical Geography, but not one child will be in your classes that does not live in a house, and is not concerned somehow or other in the condition of a home.

Why useful to all.—So much for the universality of the subject; it touches every individual personally. On the importance of the subject I have little to say; it is self-evident that as everybody, even in childhood, has a home, and as everybody, even from childhood, looks forward, however vaguely, to having to keep a house of his or her own, the being able to keep it in the best way with the least trouble, to live in the greatest comfort with the fewest drawbacks, is of vast personal importance to every unit in our schools and in our nation.

Its utility at all times.—Further, as regards the continual value of a knowledge of this science of easy living,

we must remember that the use of other branches of knowledge, even to people whose livelihood may more or less depend upon them, is only occasional, while the knowledge of domestic economy comes into use every day and hour throughout the whole lifetime of every man, and every woman, and every child.

Why hitherto insufficiently studied.—Why then, it may occur to you to ask, has this most important specific subject been so little taught hitherto in our schools, as compared with other subjects excellent in their way, no doubt, but far less necessary than this important science and art (for it is both together) of making the house that shelters us, and the home we love, as comfortable, as healthy, and as happy as can be?

Those of my readers who are already in charge of schools can probably answer the question. Domestic economy, until this year (1879), has been admitted as a specific subject for only one portion of our school children to study, namely, for girls; and the taking it up by them as a subject of examination would have entailed upon teachers the taking up by boys of a different subject—that is, would have caused, at all events in mixed schools, the labour of giving regular lessons throughout the year in at least one special subject more than was required.

This year, however, the limitation 'for girls' has been removed from the domestic economy branch of specifics, and the subject has been divided into two classes, one embracing housekeeping generally, the other food and its preparation, proficiency in which latter is still wisely made compulsory on girls, on whom, in adult life at least, the cookery of the future, and thereby in a very large measure the health and comfort of the family, must depend.

Thus we may now teach domestic economy, in its first branch, to boys—a common-sense permission, since, though in general the woman keeps the house, and prepares the food,

the man is expected to provide the house she keeps and the food she cooks, and will not be the less willing to do his own share and to value hers from knowing how both parties can best *economise*, or make the most of, time, toil, earnings, means, leisure, and good intentions, while undergoing the least avoidable amount of discomfort, privation, sickness, and anxiety of mind.

Food preparation not necessarily only a girls' subject.—Nor, let me remind you, is there any reason against letting boys learn whatever cookery maxims are taught to the girls who take up domestic economy as a subject. Some theoretical and practical knowledge of this sort may at times be of very great advantage to both boys and men. Soldiers and sailors, who have had to do without the aid of womankind during a large portion of their lives, are often very skilful and practical in preparing food ; and though most cooks are women, the most skilful and famous preparers of food have always been men.

A few general remarks.—Before entering on the various divisions of this subject which the arrangement of the Education Code suggests, I may be permitted to offer a few general remarks on teaching, which some teachers, or at least some pupil teachers, have not yet found occasion to place among their *maxims*, or chief points, in endeavouring to give instruction.

Clearness of teaching.—Let the teaching be clear. I do not mean merely that you are to avoid long words : words may be very short and yet fail to be understood ; on the other hand, they may be very long and yet be fully understood. Brevity is excellent and admirable, but only when it is clear.

The first little Scripture class I ever examined were reading this sentence, 'The ark swam on the face of the

waters.' I asked, 'Well, what was the ark?' One little hand was eagerly thrust out; no other child seemed to have a notion to express. 'Well, little man,' I said, 'I see you know it. Tell us, what was the ark?' 'A fish!' was the reply. The teacher had made the mistake of 'taking for granted' that the children knew what an ark was. Thus, though 'ark' be a very short word, it is a hard one till children be told what it means. Take a long word, on the other hand, and ask the youngest child in a school where there is a Penny Bank, 'What is a bank depositor?' and you will get an answer; the long word 'depositor' will be no puzzle to him, for he understands exactly what it means.

No knowledge to be taken for granted.—Whatever words you find it best to use, make this one of your teaching maxims, 'I will take no knowledge for granted.' It will really prove in the end a vast saving of time and labour, as well as of many a little disappointment, if you keep in mind the great need children have of explanation, to give them even a faint notion of the meaning of the words you use. It will well repay your patience in the end if you resolve never to pass from one term in your teaching to a second until you have made sure that the dullest child in the class has some clear notion of the first.

And this must be done by questioning, not the bright children who know, but the slow children who do not know, and the shy children who are not certain whether or not they have understood you. You know well enough already that, at least in class, they will never ask you to explain your teaching; so for their sakes, as well as your own, it will be always well to measure, and, if necessary, supplement the comprehension of your meaning which they gain as your instructions proceed.

Importance of illustration.—It will be well to remember that no time is really lost in giving illustrations of

your teaching to the classes. You may be quite sure that though there may be two or three children in each class whose minds are quick to grasp your meaning, any illustrations by which you can simplify it to the slower ones will tend also to fix it in the brighter minds. For instance, you tell your class as a fact (apart from its cause) that heated air rises; this is a statement that they may or may not remember, but if you light a match or candle, and show that a piece of paper held above the flame will take fire, and held beside the flame will remain unaltered, they will have a proof of the ascent of heated air which will never leave their minds. Of course, I offer this merely as a typical instance of the simplest illustration.

No time really lost in illustration.—Some may suppose that the time spent in looking for a lucifer and a bit of paper, and in giving the demonstration, will cause an unnecessary and undesirable interruption to the work of the class. This is a mistake; the loss by interruption will be balanced by the gain in interest taken, and the dullest child in the section will have not merely listened to the statement of a fact, but have gained an appreciation of it, and laid, so to speak, a brick in the foundation of its knowledge.

Nor need there be any delay in hunting for materials. It will be a piece of practical school economy of time and order, if the teacher, intending to give his lesson, have at hand, as he should, the few little materials which will be needed for making his teaching plain.

CHAPTER II.

DIVISION I.—CLOTHING AND WASHING.

Previous knowledge of the subject assumed.— We come now to consider the first year's domestic economy, which embraces clothing and washing. Of course you will understand that this little manual, though endeavouring to give hints on the different branches of the subject which may be useful in suggesting ways of teaching, does not pretend to take the place of any one of the many useful books of domestic economy which have already appeared. Probably, before taking this little work in hand, you will be already familiar with one or more of these, at least in their general outlines, and will not really need to be instructed again in that alphabet of the subject which so many useful works contain. One thing I may say,—that you cannot read too many of them. The subject, for instance, of clothing has so many sides that you will be certain to find much in every little book on domestic economy contained in none of its fellows. I will therefore assume your knowledge, and offer you some hints on the best way of imparting it.

We will suppose you, then, by the course of class teaching you have already passed through as a scholar, and by the additional reading of a number of useful manuals which you have studied, to be yourself familiar with the principles of the subject, so far as 'clothing' is concerned. We will next suppose you preparing to instruct a class, let us say of the Fourth Standard, in that branch of study. How will you

teach them? There are several ways. Perhaps, if I put these different ways before you, your own judgment will enable you to select the best.

Mechanical teaching.—Remember you have a year's time to teach this division of your subject; and, keeping this very important point in view, you turn to your manuals and find, on an average, less than a dozen not very closely printed pages assigned in any of them to the facts to be taught as to clothing and washing. You might give your class half a page a week to learn by rote, and they would have the whole bookwork of the subject at their fingers' ends in half a year. They might possibly, by inspection-time, have repeated it all twice or thrice, be able to give the inspector chapter and verse in answer to his questions, and succeed in obtaining the Government grant. But you have not the true teacher's heart and spirit if such a system as this satisfy you. Children might have the whole book by rote, and know nothing of the subject. The child who, asked by an Inspector what conscience was, said 'An inward monitor,' and, asked further what a monitor was, said 'An ironclad,' gave correct answers, indeed, to the two questions; but his teacher, on hearing them, must have felt ashamed of himself. A mere rote repetition is not what any teacher should aim at. Let definitions, if you will, be learned by rote; they will discipline memory, and simplify expression, but they must be understood, not merely gabbled.

Desultory teaching.—I will now offer another method to your judgment. A teacher asks his class why people wear clothing. They will all say, to keep themselves warm. He presses them further, and some of the quicker ones will soon see and say that clothing may be worn to keep people cool as well as to keep them warm. The next question he asks is why the same sort of thing should be used for such

different purposes. He feels he cannot well explain this without showing that the temperature of the air is variable, while the temperature of the blood in a healthy human being is constant. To do this, he thinks of the thermometer. He shows it to his class; he thinks of its name, *heat-measure*; he explains this; the necessity, in order to produce a scale at all, of knowing some fixed point strikes his mind; he tells them that freezing point may be known by the congelation of water, boiling point by the evolution of steam, and so he comes to blood-heat, which may be taken as a conventional constant.

But he wants to illustrate this: he feels that the children, if as awake to the subject as he wishes them to be, will want to understand how the indications of these fixed points in the thermometer can be made, and so forth. He has the illustration at hand; lest he should forget it, he goes on to show the mercury or spirit rising in consequence of his placing his hand on the bulb; he cannot resist showing them, in this connection, that this change is not produced by contact with other articles in the room, which are at the temperature of the atmosphere. But why, he thinks the children will wish to know, why does the mercury rise? In explanation, he tells them of the expansion produced by heat; this leads him to describe radiation and conduction of heat, and a dozen obvious and interesting illustrations occur to his mind—the wooden handle to an iron tool, the kettleholder for protecting the hands, the refrigerator for retaining heat or cold, and so forth. By the time he has got thus far, keeping up no doubt the interest of the children, and inviting additional illustrations of his statements from them, the hour strikes, and the lesson is over. This is an infinitely better sort of lesson than the first. There has been no dry mechanical drudgery in it. The children have been told a number of new things, their attention has been kept awake, their conduct has been good, and they have been won into actual thinking, as well as

reasoning; and though much of the lesson will be forgotten, still something will have been done towards giving them an increase of actual knowledge. And yet this may be a very faulty sort of lesson. My keener and more experienced readers will recognise why without my telling them; though most people, standing behind a pupil teacher while giving such a lesson, might feel with pleasure that he or she was really full of the subject, and zealously anxious to communicate the required knowledge.

Its faultiness.—The rote lesson was bad, as employing only the memory without the intellect; as being mechanical, but not instructive; as conveying teaching, but not learning. The second lesson errs the other way. It puts forward vastly too large a meal for the mental digestion. As the first lesson may be starvation, so the second may be surfeit, and its deluge of new ideas may utterly confuse some of the scholars' brains.

And whence will this confusion have arisen? If we look for the reason on the surface, we shall find that the teacher, in giving his lesson, has become desultory—that is, has been bounding from point to point, from illustration to illustration, a great deal too hastily. This is no proof, you will admit, that he is master of his subject; quite the other way, it proves that his subject is master of him. He has been unwilling, as he fancies, to leave anything out from his exposition, and as each salient point of the subject has entered into his mind, he has seized on it, and made it prominent, that very moment, *lest he should overlook it afterwards.* He has been going up, like a head-heavy kite, with a dash and jerk, now to one side, now to the other, and though he has risen to some height his position is unsteady and precarious; having gone up in a series of flashes, he may, so far as the benefit of his lesson goes, come down in a succession of flounders at the last. What does the head-heavy kite want? Just what the teacher wants—steadying.

His method wants the ballast of system; his thought must be tempered by forethought, and his zeal be directed by preparation.

The systematic lesson.—With this caution before you I would suggest your making the experiment of proper preparation for a lesson or lessons on the same subjects as I have set before you in the picture of an hour's desultory teaching. You will see at once that the main fault of the exuberant lesson was that, not beginning at the beginning, the instructor had to work backwards instead of forwards. The task being to teach children why clothing was wanted, both for warmth and protection from warmth, it is obvious that the first essential foundation on which to base such teaching should be a knowledge of the leading principles of heat and cold. From these would come out, not by the chance suggestion to the teacher's mind of some passing illustration, but by a clear and definite logical process, the necessary and simple evolution of such points, for instance, as I have hinted at in the desultory lesson.

Its proper course.—Starting thus from first principles of the nature of heat and cold, the teaching will follow a clear and simple course; in regular order, as it proceeds, like the successive affluents which make the brook into a river, the knowledge of expansion and contraction, of radiation and conduction, of the thermometer and its indications, of the variable temperature of the atmosphere and the fixed temperature of the blood, and finally the simple reason (which we have adduced as illustrative) of clothing being required for two apparently quite contrary purposes, will all be taught in proper course: if apparently more slowly, yet unquestionably more soundly, with better purpose and with greater profit, than by the desultory method.

Economy of systematic lesson.—I must not linger longer over this warning as to the superiority of systematic over spasmodic teaching. For a teacher to prepare carefully the lesson he means to give, to have his illustrations thought out beforehand—written down, if he will, on a note-slip, to aid his memory—to be ready to exercise a stern self-denial, by resisting all temptation, as the lesson proceeds, to reach forward to some more advanced portion of the subject, for the reception of which he has not yet prepared the minds of the less intelligent of his class—in a word, for the teacher to *plan his lesson and adhere to his plan* is, in the end, a real economy instead of waste of time and trouble and teaching power. And it has another vast, but little considered advantage. It trains the children into systematic habits of thought and attention; it makes them, through such discipline, vastly more susceptible than they would otherwise become of clear, definite, systematic instruction; and as they grow older, and have deeper things still put before them, the greater receptivity of their minds, and the habitual logic of their thoughts, will have made the task of imparting higher teaching infinitely easier and more interesting to their instructor. This will repay him a hundredfold the conscientious trouble he has taken, by the mastery his clear teaching will have given him over his pupils' minds, besides multiplying their mental power and his pleasure in its development.

Objects of clothing.—You will show these to be threefold—(1) for keeping heat in; (2) for keeping it out; (3) for ornament.

Ask the children which is the most important purpose. In our climate they can scarcely fail to give the first place to the first, and the last to the third. Proceed then with instruction on the clothing which retains heat. Having shown them that the body requires to be kept at a very equable temperature, give them practical illustrations of the different powers

of different materials to retain heat. This, of course, must exemplify the conduction of heat; but I think you will save their minds from confusion by avoiding the use of two very common terms—a *good* conductor and a *bad* conductor. Remember that your young pupils will be very apt to suppose from such terms that good conductors are good *things*, and bad conductors bad *things*. You will find it better to speak of *fast* or *slow* conductors instead.

Illustrations of conduction.—It will interest them to show differences in conducting power by such an experiment as the following. Have a number of little cuttings (an inch or two square will be abundantly large) of flannel, cotton, and linen; wet them all thoroughly, squeeze out the water, and let each child place a wet piece of each on three different fingers. Then let them each blow from a distance of about six inches upon the wet rags, and ascertain which fingers feel the cold current most. When you ask them they will all give the following order of experience—linen, cotton, flannel; and this is an illustration they will never forget. (You can use it further very effectively when you come to teach them of evaporation, and the reasons and risks of catching cold.)

You can go on to teach them general facts about the clothing that keeps heat out, so far as this is identical with the former. They will be interested to know that the same material which keeps warm bodies warm will keep cold bodies cold. You can exemplify this by telling them that when it is desired to keep a lump of ice as long as possible from melting in summer, it should be (and generally is) wrapped round in several folds of blanket; and that the so-called 'Norwegian kitchen'—a felt-lined box which will keep a man's dinner hot for a number of hours—can be also used as a refrigerator to prevent the melting of a block of ice. If it be winter, and ice be at hand, let two equal pieces be brought, and let one of them be wrapped in woollen, while

the other is freely exposed to the atmosphere of the school-room for half an hour. If the weather be too warm for ice to be found, two hot potatoes may be treated in the same way, and fully illustrate the point taught of the retention of heat and cold.

Texture of clothing.—Having got so far in showing how differently linen, cotton, and woollen conduct heat or cold, and why they are therefore, from their effects on the body, *called* cold or hot, though their temperature be identical, you may make your scholars clear on the subject of *texture*. Starting from the meaning of the word, which implies *weaving* of some sort, you should give them some sort of notion of the manner in which this is done. Hand to one a piece of linen, to another a piece of cotton, to a third a piece of cloth, in each case with selvedge on one side, and let them pull out a thread each way, or show them how to do it. They will see that, however different or combined the materials be, one principle is applied in the texture of all, namely, the alternation of threads forming respectively the woof and the warp. Incidentally you may show them that, by ravelling any piece of stuff, they may find out for themselves whether the fabric be, we will say, all silk or half silk and half thread, all wool or half wool and half cotton, and so forth. Having shown these general principles of texture, you may point out exceptional textures, such, for instance, as appears in a knitted sock or garter, a chip hat or a piece of straw plait, all of which are textures, that is, are woven, though by methods differing from that of the weaving loom.

Clothing without texture.—Though most of our clothing is made by texture or weaving of one or another kind, there is still some of different character. Set your class thinking of instances of this. If they do not guess them at once, make them think how man was first clothed, and they will at once recollect that skins were used for this purpose long before weaving could have been thought of.

From this starting point they will find out and name most articles of clothing made of fur and leather. In connection with the first of these you may (if the district be rural) give them some valuable hints as to the use that is so seldom, and might be so often, made of rabbit skins to make winter cloaks for little children. Passing from fur, you should give them some instruction as to the preparation and use of leather, chiefly for clothing the feet and hands, &c.

Other substances not textile.—These are to be found in materials of clothing manufactured out of pulp instead of from spun threads of various kinds. Typical illustrations of these are easily found in paper of any sort, and in the felt of which hats are made. A piece of blotting paper pulled asunder will give the children an idea of the difference between such substances and any woven material. And here you may take occasion to show how large a means of retaining heat is wasted by neglecting the use, in many instances, of a material so cheap as paper, at least as lining to clothes, and as a supplement to bed coverings.

Waterproof clothing.—Another class of materials for clothing, though of occasional service, can yet prove extremely injurious to persons employing it unwisely. I mean waterproof clothing, the great cheapness of which affords too strong a temptation to its misuse. Except in the case of overshoes actually moulded out of caoutchouc or india-rubber (and which are now very seldom seen), nearly all waterproof clothing consists of a layer of impervious material spread over a texture which varies from the fineness of silk to the coarseness of a canvas tarpaulin. To keep the feet from wet in going a short distance, or to protect the clothes from injury during a passing shower, these things are very useful; but as they prevent the passing out as much as the passing in of moisture, and the body is continually sending forth moisture through the skin which

the waterproof keeps from passing into the atmosphere, a person wearing a waterproof suit for an hour to keep his clothes dry from rain, will, on taking it off, find they have become wet from perspiration.

Of course the objections to the use of these substances apply in kind, but by no means in degree, to the use of skins. All textures, by the necessary interspace of air, however small, between the alternate threads of which they are composed, are more or less *pervious*; and skins also, being full of pores or little passages, permit a certain though less easy passage in or out of air; while macintosh or waterproof, being entirely impervious, destroys this quality in the texture on which it is spread, and retains the moisture of the body.

Form of clothing.—Under this head I will touch merely the subject of suitability of garments in shape to their purpose, not the passing mode in which they may be worn, commonly expressed by the word *fashion*, which strictly means the manner in which clothes are made, though we generally apply it to the fancy which dictates the shape.

Teach your pupils, in the first place, what principle the form of clothes should follow, as a means to an end. They will admit, if questioned, that a leather boot or shoe cannot be essential for the creation or retention of warmth, since this can be effected by cloth, cotton, linen, or other coverings. They will then see that protection is what specially necessitates such covering for the feet. Show next the folly of making what should be a protection into an injury, as is so often done by the bad form of shoes. Apply this by asking every child whose foot has ever been pinched by a tight shoe to hold up a hand. You will be pretty sure to find many sympathisers with this view of the subject. Ask them in what respect the form of the pinching shoe was bad; one will say 'it was too short,' another 'it was too narrow,' according to each one's experience. On this

you may base an illustration. Ask whether one of the well-shod ones will take off his boot or shoe, that something may be shown. But do not call on anyone at random to do so; he may prove to have either no sock, or a very questionable one, on, and be unwilling to submit to an exposure. None will volunteer who is not easy in his mind on the subject of socks. Tell him to put his boot or shoe flat down on a sheet of paper and to draw a line round it. Next, let him place another sheet on one of the benches, put his foot lightly upon it, and then draw its outline. The children will thus be shown the vast difference in outline which exists between the natural shape of the foot and the conventional shape of the shoe. But there will be more to show. Let him next stand on his one unshod foot upon a sheet of paper placed upon the floor, and let another child draw upon the sheet the outline of his foot. Let these two outlines be exactly cut out with scissors, and it will be found that the second one is always a great deal larger than the first. This will teach the children that a shoe made to fit the lifted foot exactly may be much too small for the same foot when bearing the weight of the body, and give them a notion of the cause of so many misfits.

Next make them think of another reason for shoes pinching young feet. They will soon tell you that this is caused by the feet growing against the shoes. From this you may teach them that their new shoes ought always to be too large at first, though exactly fitting ones may look nicer when first tried on.

You may, if you please, illustrate the subject further by telling them of the Chinese custom of deforming the ladies' feet, and show them the folly, as tending to deform and hurt the foot and waste the muscles of the leg, of tight narrow shoes, and above all, of the high heels placed not under the heel, but under the arch of the foot, which spoils the comfort, ease, and grace of so many women's gait at the present time.

If it be winter, let them show, by holding up hands, how very many more children have chilblains on the feet than on the fingers; and let them learn that these, all arising from bad circulation of blood, would probably not occur to any children on the feet only, but for their feet growing against the shoes. Those whose circulation is naturally sluggish will have chilblains both on fingers and feet; those whose circulation is impeded by tight shoes will have chilblains on the feet, but not on the fingers where the circulation is natural and unimpeded.

I have taken the instance of foot clothing at some length, in order to afford a sample of how lessons on this subject may be given. There are many other articles of dress which may be similarly treated, and which afford abundant means of supplying children with common-sense views on the form of clothing. Thus the evils of tight lacing, and of leaving arms, necks, and legs of children exposed to cold, and the like, may be very practically taught.

Clothing as an ornament.—This will require some treatment from you after you have fairly exhausted the subject of clothing in its primary aspect, as used to retain or exclude heat. And here a certain amount of caution is necessary, lest you give children some indistinct ideas as to the right or wrong of regard to appearances in dress. To say that care for appearances is wrong would lead some to think there was a merit in wearing rags; to say that people should dress according to their means would lead others to think it right to wear any amount of finery which can be paid for. Between these two general statements there is room for inculcating a great number of sound and useful ideas on the subject of ornamental clothing. There is no reason, for instance, why, when a woman gets a new dress, she should have it made in the very shape that was common twenty years ago, because in such a form it would look strange beside other people's dresses of more modern shape; nor is

there any harm in her having it made in a form which she thinks will become her, rather than in any other; but still her dress should be suitable to her station, to her surroundings, and to her habits.

Quality of clothing.—By all means prevent the children confounding *good* clothes with *fine* clothes. And do this by questions, which will lead them to understand that one's week-day working clothes, though they cost little, may be good, while what they are apt to call *best* clothes may be flimsy, wasteful, and bad. Make them see a possible difference between 'Sunday clothes' and 'good clothes.'

Of course there are a multitude of other points in connection with clothing, to which, if space permitted, I might draw your attention. Think them out for yourself, and bring them into the lessons you prepare for your classes. It will be both interesting to yourself and advantageous to them.

Washing.—With regard to this subject, much cannot be done in a school class, beyond putting forward general principles. As far as the theories of dirt and its danger, and of cleanliness, its healthfulness, necessity, and comfort, are concerned, the matter is nearly obvious. Something practical may be done, besides giving the hints as to materials and methods contained in the text-books of 'Domestic Economy,' by encouraging the children to compete with one another in the actual art of washing, each competitor attempting the getting up at home of one article of the same sort. Even boys might be induced to try this, first in competition with each other, and afterwards with the girls. Soldiers, sailors, and Chinamen are noted for success in laundry work. Very few mothers would object to letting their little ones make a few trials over the weekly or fortnightly washtub, as the practical knowledge thus gained might prove of real and early home value; and indeed

parents generally approve schools whose teachers try to impart at least the desire of doing something visibly and unmistakably useful.

Of course care should be taken that the efforts made by the children be honestly unaided at home ; and the decision as to merit should be left to the votes of the little competitors themselves.

CHAPTER III.

DIVISION II.—THE DWELLING.

The dwelling.—The first stage of our subject has been that of clothing and washing, the preparation and proper care of the garments we put on. To be scrupulously exact, we may say that, if *economy* mean *housekeeping*, the mere covering of the body does not necessarily belong to it. But this second stage beyond all question does, for the keeping of a house of course implies there being a house to keep.

Importance of subject.—The importance we should attach to useful knowledge on this subject depends upon our estimate of the value of life itself. A vast proportion of our fellow-creatures, even in England, have their lives as surely shortened by the badness of their dwellings as they would be by their taking a regular dose of slow poison every morning of their existence. Set to work, therefore, to teach this part of domestic economy to your class with most zealous care, as knowing that in doing so you are really, with every lesson you impress upon your hearer's brain and memory, conferring a tangible advantage and blessing to them all.

Supposed uselessness of teaching the subject.—It may be said that our labouring classes need hardly learn how houses are, and how they should be, built, because not

one in a hundred of them will ever be able to build a house for himself; that he will have to take all through his life just whatever dwelling, good or bad, may offer near enough to his work; and, if its condition be bad and unhealthy, he will have no choice but to simply take his chance of sickness, weakness, and death; that it will never be in the power of the poor man to reform dwellings which he rents from persons who have no necessary interest in his health and well-being, and who look only for the rent he promises to pay, not to his easiest means of earning it. There can be no greater mistake than this. If all our school children be taught while children to know the difference between a bad and a good dwelling, and how much really cheaper it is to pay even a high rent for a good than a low rent for a bad one, the builders and owners of houses will be compelled for their own sakes to erect good houses which tenants will take, instead of bad ones which will stand empty. Even now, as a rule (of course I speak of heads of families, not of children), the worst characters are generally found to occupy the worst dwellings; the steadier and thriftier members of the community refusing to work in neighbourhoods where they cannot live under healthy conditions.

This answers the assertion that the working classes cannot reform their dwellings. They can and will do so, for it really lies in their own hands, if they be properly taught, as you and others must try to teach them.

Hopefulness of subject.—But there is no need to assume, as we did just now, that hardly any child you teach will ever need to build a house for himself. I think you will gain much more attention to this subject from your class by teaching them to believe it possible for everyone of them, if thoughtful and prudent, to build a house for himself when he grows up. They will be thus much more interested in learning how it should be done, for you will probably remember that in your own childish days there was

no game which gave you greater pleasure than playing with your companions at house-building of one sort or another.

As to the means for doing this, I shall have a few words to say when treating of the third stage of domestic economy; you will have enough to do during this second one if you fill your pupils' minds with sound knowledge as to the nature and condition of a healthy dwelling.

And this, you will remember, may be of great immediate practical advantage to them long before they may dream of saving money to build homes for themselves, since instruction in the conditions requisite to make a new house healthy will suggest at the same time many directions in which old and unhealthy houses may be rendered safer and better by the expenditure of a little thought, trouble, and money.

Analogy between clothing and shelter.—Make your class understand that a house is required for much the same reason that clothes are required, namely, to keep up the proper natural temperature of the body, and then much of what you have been teaching them as to clothing will prove useful as you teach them about dwellings. Let them show you reasons why shelter is essential to man in addition to clothing; these reasons lie, of course, in the heat of the sun, its excessive brightness, in the difference of day and night temperature, in the exposure to rain, and the cold of frost. If a temperature suited to human life remained always the same day or night, unaltered by sunshine, cold, or moisture, men would only need houses for the purpose of keeping their property safe. The same sort of objects, therefore, should be sought for in a suitable house as in suitable clothing. For this reason you will show why, for the outer structure of houses, at least in our climate, slow conducting materials are better than fast ones. Thus the children will understand at once that thick walls and roofs are better than thin ones, for keeping heat and cold in or out, even though both be alike

in the immediate protection they give from wet. Let them try for themselves the experiment of taking up a heated kettle with a straw kettle-holder, or a piece of tin or even of slate, and they will remember always that a straw thatch will make a warmer winter and a cooler summer roof than slate or sheet iron. Offer to lend a thermometer to any of them who would like to test this truth by noting the temperature in bedrooms or garrets immediately under roofs of different sorts. This will interest as well as teach them; and if any making the experiment should come back reporting it to have failed, it will give you an opportunity of teaching them a great deal more, by questioning as to secondary conditions affecting the experiment which they had failed to take into account. For instance, you would ask whether there had been in winter a fire in the slate-covered and none in the thatched room; or if in summer they reported a higher degree of heat in a thatched room than a slated one at the same hour of the day, you would ask whether the sun had been shining equally on them both, or whether its heat had not been intercepted or shaded from the thin roof by a tree, &c.

Further outer structure of dwelling.—You can then go on to show the advantages (not at the same time omitting the possible disadvantages) of double walls enclosing air spaces, of double doors, and even of double windows, which in some colder climates than ours are considered nearly indispensable.

Let the children next instance to you the various materials of which houses are built, as, for instance, brick, stone, wood, iron, mud, concrete. Teach them the relative advantages of these, modified as they must be, of course, by considerations of supply, carriage, prime cost, durability, salubrity, expenditure of labour, comfort, and even appearance, which is certainly a factor not to be omitted in calculation. Make them understand that none of these

can be absolutely best in every place, materials which are abundant in one locality being entirely unobtainable in others.

Disadvantages of an unhealthy dwelling.—Of whatever material a dwelling may be built, there are certain conditions to be observed in its position and erection, the neglect of any one of which must render the dwelling unhealthy. Show your class why it is foolish for a man to live in an unhealthy house because the rent is low. Let them calculate, if sickness caused by the unhealthiness of the dwelling arise, how great a cost may have to be incurred in a year for doctor's attendance, for medicine, for wages unearned during sickness, for loss of time by others while attending to the sick, even apart from possible funeral expense, the shortening of many lives, and the anxiety, sorrow, and trouble which can never be calculated at all. Let them see how terribly larger such expenditure is sure to be than the small sum every year, or even week, necessary to provide a healthy rather than an unhealthy dwelling. This will make them ready to think and to be shown how to distinguish a house that must be unhealthy from another.

Essentials of a healthy dwelling.—Of course they will readily understand that a house which provides a cause for sickness must be unhealthy. Let them think or be shown how we are affected by disease; then they will see that (1) if cold and damp cause disease to lungs, and rheumatism, a dwelling hard to warm and not weather-tight, so far as keeping out wet, must be a bad one; (2) that if spoiled or infected air causes and spreads disease, a house from which it is hard to drive away bad air and replace it with good, that is, a house not well ventilated, is a bad one; that if decaying and putrid matter breed disease, a house without good drainage for carrying away such infectious and poisonous matters must be a bad one; that if

light be one of the necessaries of health, a dark gloomy dwelling must be a bad one, injuring both the body and mind. Thus you will have got your class to accept as a maxim that a damp, ill-ventilated, ill-drained, gloomy dwelling must be a bad one, and dear if it could be had rent free, as well as deadly at last, even though men might live in it for years.

Alleged disadvantage of such teaching.—It may be said that to teach young people, many of whom live in unhealthy dwellings, such matters as these tends to make them discontented with their homes. It will not be so. Firstly, it will tend, in time, to make the homes better, even as a market speculation. If working people be taught in school to know the advantage of a healthy dwelling, unhealthy ones will not be rented on any terms; and further, the pointing out of deficiencies in the dwellings they live in may set the school children, and through them their parents too, to remedy, as may to a great extent be done, faults or disadvantages in the dwellings they now occupy. Let us touch, then, briefly on the line of teaching to follow in regard of the more important conditions necessary to make a house healthy.

Protection from damp.—Find out from your pupils their notion as to the coldest and dampest aspect of a house. If they cannot tell, and have never thought, tell them to try, by next lesson, to give a better answer. Let them, for instance, go round the church and look what parts of it are most damp. There will probably be a vane on the tower or spire, so that they will not mistake the cardinal points; they will most probably all agree in calling the north side the worst. They will judge it by the apparent moisture of slates, or moss between tiles, &c. Ask them why should this be, if the south and west be the quarters from which our rain for the most part is brought? Lead them gradually

up to notice that the sun, which evaporates damp, shines on the east in the morning, the south at mid-day, the west at evening, but not on the north, and they will have learned a notion of the importance of *aspect*.

And this is a far more weighty matter for the young who live in towns, and sometimes in single rooms there, than for those dwelling in the country; since most cottages, as standing separate, look every way, while town houses as a rule can only face two points, and are often so divided that the dwellers in them can never face more than one. To dwellers in such houses, aspect, both for the evaporation of damp and for the supply of light, is of vast importance.

Danger of damp walls.—Great discomfort and danger arise from walls which constantly absorb moisture, and consequently are always producing a cold evaporation. Teach the children the vast importance of a 'damp course,' of slate or other impervious material, let in near the foundation of a building, to check the ascent of moisture from the ground. Of course this will not help houses already built without such precaution; but it will teach your pupils, when their time comes for choosing a dwelling, to know what to ask for, and so, by making demand, do their share towards producing the supply. Suggest to them to think of ways to make damp walls less damp. This may be done, when caused by ascent of wet from the ground, by the small trouble of making a little drain of broken stones along the wet wall outside, and drawing down the moisture into a little cesspool instead of leaving it to be absorbed into the walls. If the damp wall be caused by soaking of rain (commonly on the south-west or rainy side of the house), weather slating can be made of great service.

Sanitary self-help.—Show your pupils that though these be, as well as the mending of a rotten door-jamb or a broken window-frame, landlord's repairs, yet, if the landlord

will not attend to them, and the tenant can find no other dwelling, it is really cheaper, as a matter of health, happiness, and unimpaired earning power, for the tenant to execute such repairs either by his own hands or at his own expense.

Drainage of dwelling.—Your class teaching on this point, again, though based on the same first principles, must take different directions, according as it is addressed to dwellers in town or country. It may seem a strange thing to say, but in all reason the most sensible foundation on which you can begin the teaching of this subject is the question to the children, 'Why has a human being a nose?' From this you can easily lead them to see and remember that, at all events under our present social conditions, the sense of smelling is given us not nearly so much as a source of pleasure and enjoyment, as a means of protection and warning. Of course there are differences of personal tastes; people differ as to beauty of persons or places, they differ as to calling certain sounds, such as music, &c., delightful or otherwise; but there is certainly a universal consent as to a disagreeable odour being a bad smell, and a bad smell an unwholesome and dangerous thing. Show your pupils something about the generation and expansion of gases, especially of noxious ones; how they must naturally be evolved from decaying and corrupt matter of all kinds, and of how great danger to health, not only as conveying an independent poison to the human system, but also, in countless cases, as conveying direct germs of deadly disease from one human being to another. Argue the question through with them, till you find them come to the conclusion you would lead them to—that, as these gases must naturally be evolved, it is necessary to human health and safety that they should be rendered harmless. They will soon understand, first, the necessity for the removal of putrid matter from immediate human neighbourhood, and, secondly, the necessity for dilution of the noxious gases by exposure to air.

Cottage drainage.—Point out the vast advantage of drainage conditions which country life gives to one who knows the first principles of this most vital subject. In the country, where space is abundant, let them learn that nothing but indolence and ignorance need prevent a cottager's home being safe from the peril and plague of sewer poisoning. Point out the common sense of having no outdoor closet placed on higher ground than the dwelling-house, or within reach of possible percolation into a well; how the shallow cesspool may poison the deep well, which never could cleanse the cesspool, and so forth. Do not be afraid to put the matter plainly before your class. Ask them in what houses a sewage smell is found; question them as to means for its removal, which is almost invariably possible, and often ridiculously easy; and give them some simple hints as to disinfection by admixture of earth, ashes, &c. Stir up the boys to a sense of dread lest they neglect such things, and to a sense of duty in trying to remove and remedy them with their own hands, and you will find the lessons of good effect. You cannot too plainly enforce upon them that any alleged neglect on the part of landlords, inspectors of nuisances, or sanitary boards is no excuse for even the very poorest labourer letting himself and his family be poisoned, hour after hour, by causes which a little trouble would remove in less time than is often spent in grumbling about it.

Town drainage.—With regard to this you will have a harder task to teach than on cottage drainage. Bad sewerage need not exist in country cottages, since in the country sewers are not absolutely necessary, and can be better done without if the occupiers are even moderately cleanly and not immoderately lazy; but an epidemic of sickness may affect thousands in a crowded town district from the generation and escape of poisonous emanations, for which not one of the afflicted residents can be blamed. You must show your class the principles of town drainage, giving them notions of main drainage and

outfall, of house drainage and its connection with mains, of the risks involved from a flooded sewer, a broken pipe, sewage-saturated brickwork, or an imperfect trap. These things you should make them familiar with in a general way, explaining the principle, at least, of traps by models and drawings on the black-board. But no lessons and no explanations on these points can be half so useful as the teaching every member of your class the general duty of doing battle against bad smells in dwellings as against a possible plague or pestilence. The dweller in a single room of a crowded court cannot tear open pipes and burst up drains; but he can, and he should, wherever he detects the evil smell of sewer gas, call in the sanitary inspector with the least possible delay, as the first step towards setting matters right. Therefore set your class as a home lesson to bring you word who is the sanitary inspector of the district they live in, where his office is, what his office hours are, and so forth.

Warming.—The handbooks will give you most of the necessary details on the subject of artificial heating, so far at least as common materials and common methods are concerned; and we have already touched the subject of warming incidentally, as regards the quick or slow conduction of heat to be considered in choosing materials for the structure of a dwelling. But there is probably no point so important as this of keeping up, when needed, our health and strength by means of artificial heat, in which English people of every class suffer so much unnecessary discomfort, and contract so much sickness, from sheer ignorance and prejudice.

Romance of open fire.—In the first place, teach your class the fallacy of the general objection made to the use of a close instead of an open fireplace. Ask them why they or their parents prefer it. They will all say, 'We like to *see* the fire.' Show them, in reply, that they only fancy

this, because with them *seeing* the fire is their only way to feel the fire, and is a proof of the cold they suffer rather than of the enjoyment they have in the mere sight of a blaze. How will you prove this? The way is simple. Show that all through the summer they do not *see the fire* and do not think of it, except for cooking purposes, and that though the grate be cold and black and empty the absence of fire does not depress them, simply because they are warm and comfortable without it. They will thus learn, in theory at least, that if the room be comfortably warm they really do not occupy their minds about the fire. And this will be a step gained towards the introduction of cheap and effective warming, of great importance in the present day when fuel of every sort increases so much in cost. But theory alone, however sound, will not prevail against prejudice, and children, of course, have no means of putting into practice and making proof of the truths they may be taught in school upon this subject. Nor can much be done in the way of uprooting this prejudice until opportunities be given for experimental proof, which poor people cannot afford to make, of the superiority for warming and culinary purposes of a well-constructed stove, made to close or open, with narrow flue, over our present old-fashioned, foolish system of large open fires under wide chimneys, necessitating enormous and constant draughts of cold air into the rooms to secure a rapid and yet imperfect combustion, and at best a fitful and ill-distributed warmth, at a most unnecessary expense, both of cost, cleanliness, and comfort. With regard to warming and heating for culinary purposes, more will be said in the handbook treating of the preparation of food.

Cleaning of the dwelling.—On this point, so far as practice is concerned, we have not much to say, it is so much a matter of practical experiment. But even a teacher in a school may do much towards promoting zeal and effort

in this most important matter by inducing the children under his charge to compete by each undertaking on a Saturday the thorough cleaning of a room at home, and by getting some experienced person to go round the competitors' homes, say at eleven o'clock, in order to decide which child may have done best. The conditions of the contest should not exclude the mother's *advice*, but her active co-operation, of course, should not be allowed.

At one time the competition might be as to the entire cleaning of a bedroom ; at another time (for which a Saturday afternoon instead of morning should be chosen) the cleaning of kitchen and scullery ; at a third, that of stairs, passages, and offices. It is quite wonderful how much pleasure children will take in such efforts, and how, if proper hints are given, parents will welcome and encourage the teacher's desire to promote practical teaching of any kind to be carried out in the home. But even where parents generally might be listless or antagonistic, children, with a little management, might be got to compete, say four each week, in the Saturday scrubbing and cleaning of the school itself ; and might have a good pattern set before them of how cleaning should be done (at least in the country, where the master's house generally adjoins the school), if the schoolmistress know and practise in her dwelling those rules of systematic household cleanliness, which children may be made to learn, but will never carry heartily out without the aid of visible example.

Ventilation.—In a school where animal physiology is not taken up as a special subject, a teacher will hardly be expected to give a class much instruction as to the *rationale* of respiration, which more or less renders necessary both ventilation itself and a knowledge of its principles. But, however little of such teaching be given, the study of the subject may be very much aided by once for all enabling the children to contrast the effects upon their own persons

of the inhalation of spoiled or of fresh air. Of course such a contrast lies close at hand, between the crowded schoolroom and the outer atmosphere, but is often overlooked for the simple reason that the schoolroom, *when the children first enter it*, is generally full of fresh air, which is more or less gradually, and consequently less perceptibly, spoiled by the admixture of carbonic acid gas as the hours go on. If the teacher wish to let the children remark the contrast in the most striking way, he will send out a section of his scholars for five minutes shortly before the end of a school-time, and let them report on their return the difference of atmospheric conditions they are able to notice.

But this may prove after all but a small difference if the school be, as it should, effectively ventilated. The teacher must send his scholars elsewhere for an illustration; let him suggest their recollections of the atmosphere of a bedroom, where several persons have slept, before the windows have been thrown open and ventilated—before, in fact, as the excellent common phrase has it, it has been *aired*—and they will have a practical sense of the difference between pure and spoiled air. It will not be hard to show them that such spoiled air, in proportion to the degree of its spoiling—that is, to the amount of carbonic acid gas with which it becomes charged—may be either called stuffy, close, oppressive, stifling, or, finally, deadly; that from being at first disagreeable it becomes, through various degrees of difficulty, impossible to breathe without suffocation and death. This will give the children a notion of the vast importance of ventilation, or the supply of fresh air, since, seeing that its neglect in the extreme is fatal, they can easily judge that the same neglect in any degree is deleterious.

Composition of fresh air.—On such a practical basis you may found further instruction as to the component parts of the air we breathe. It is hardly wise to make this teaching too definite; for instance, let them learn that air contains

about one-fifth of oxygen and four-fifths of nitrogen, with a very, very small proportion of carbonic acid; the giving them the exact fractional proportion of $\frac{3}{10000}$ really conveys no clear notion to their minds. Having shown them, however, that the proportion is very small indeed, you will give them a very good notion as to the importance of ventilation by telling them that air *after* breathing has one hundred times as much of the poisonous carbonic acid gas as it had before it was taken into the lungs.

The very name of carbonic acid gas will lead you to show that it can be evolved by all combustion of all fuel, not only such fuel as is consumed in the bodies of animals; that fires, candles, and gas lights which we burn all emit more or less of it; that the burning of a single candle produces as much as the breathing of a child. Make them recognise this by their own experiences of smoke and lamp gas of every sort, by the closeness and 'stuffiness' produced in crowded and brilliantly lighted rooms, &c., and this will lead you to another point—namely,

The possibility of ventilation.—You have shown them that as the lungs must get rid of spoiled air from the body, so, for health's sake in a low degree, for life's sake in a high degree, man must get rid of spoiled air from the rooms in which he lives. But the mere breathing out of spoiled air would not secure the being able to breathe in unspoiled air in its place, unless there were some means of taking the spoiled air away from the spot where we get rid of it. If the spoiled air remained at the level of our mouths, all the air our mouths could draw in would soon be bad. So you come to teach effectually another truth referred to in a former passage of this little book. The air we exhale, carrying away proceeds of combustion, is, like the smoke from a fire, warm air. Warm air, being lighter than cold, must rise above it, exactly in the same way as a stick thrown into a pond rises and floats on the top; and so

a means is provided whereby all the spoiled air rises above us, leaving the level of our lips and nostrils surrounded by air still unspoiled. Thus, in the open air, ventilation is not indeed unnecessary, but it effects itself by the operation of a great law of nature. But in any enclosed space all the air may become spoiled unless means be adopted for replacing the spoiled air by fresh.

The process of ventilation.—Show your class the meaning of the expression, 'Nature abhors a vacuum.' Many simple experiments will illustrate it. Let them learn that air, which they cannot see, acts exactly in the same way as water, which they can see, rushing in where possible to fill an empty space. As an illustration, let them place their hands six inches from the keyhole of the school door. Thus they will get an idea of the common sense of a draught of air. From the nature of this they will understand the principle of ventilation, and that if they can provide a means for the escape of spoiled and the entry of fresh air into a room, nature itself will effect the needful change. Of course they can exemplify this for themselves by setting door, windows, and chimney (if blocked, as they too often are) wide open in a stuffy bedroom. In practice they find all the air changed in a few minutes. The ventilation is complete. But circumstances may render this method, however effective, a very unwise one to follow.

Precautions in ventilation.—Unoccupied rooms may be thus cleared of foul air; wells and mines can be cleared in no other way than by systematic and violent movement of air currents set in motion for the very purpose; but in buildings and rooms, of whatever size, occupied by living persons, too direct and violent currents of air may cause most dangerous differences of temperature. The rational way, therefore, to ventilate occupied rooms, in which carbonic acid gas is being always gradually generated

by combustion of air in the lungs (or of any other fuel in any other furnace), should be to replace the spoiled air as gradually as it is generated.

Point out, therefore, some of the common methods of modern ventilation—the advantage of opening, for instance, both sashes of a window, so as to allow the heated air to escape above, and the fresh air to enter below; as the children will all have heard of the danger of a draught, they will readily understand that the best principle of ventilation is to admit the fresh air above the level of the occupants' heads. Before leaving the subject, you may also give them some good teaching on the subject of *draughts of air.*

A draught of air.—Make every child breathe out the contents of his lungs against the palm of his hand. They will find the air warm. Let them narrow the space through which they breathe, till they blow out the air; it will be cold. Let them narrow it still further and expel the air in a whistle; it will be colder still. Thus they will see that the same volume of air may be hot, cool, or cold, according to the speed with which it passes. From this they may judge that the opening wide of a window or door, though it may admit a large amount of air, will not be at all so dangerous as opening only a little part, through which the air will enter with greater force and strike with greater coldness. From this they will further understand that just in proportion as the heat of the chamber exceeds that of the outer air will the force of fresh air at its entry be, and in consequence that the more crowded and heated a room may be the greater is the danger which lies in ventilating with fresh air from below instead of overhead.

CHAPTER IV.

DIVISION III.—RULES FOR HEALTH; MANAGEMENT OF SICK ROOMS.

THE supply of 'rules for health' of course must be looked for elsewhere than in a manual which only offers hints on the teaching of such rules, for which we must therefore refer you to the handbooks, and pass on to give suggestions as to the teaching of sick-room management.

Sick-room management.—What has been already pointed out with regard to heat and cold will have given you a foundation to work on with your class on the first important point of this subject, the temperature of the sick room; but it is chiefly as regards good ventilation that this is to be called the first point of nursing. If a constant supply of fresh air be necessary to keep the healthy body in a healthy state, it is of even more paramount importance to secure such a supply to the body in a state of disease. Press this most forcibly on the attention of your pupils. Ask them to think of sick rooms they have been in, and of the bad air too frequent in such chambers; and, remembering what we have gone over with regard to the evolution of carbonic acid gas, lead them to see how bad ventilation in a sick room may be poisoning the patient whom we wish to cure. Suggest to them means for securing this: for instance, the covering up or screening off the patient's bed from draught for a minute or two every half-hour or hour while the whole spoiled air in the chamber

is replaced with fresh by opening door and windows; or again, the keeping up of a small fire in the grate, even though heat may not be wanted, in order to secure the movement of air; the 'heroic' remedy of beating out a pane of glass from a window not constructed to open, and so forth.

Washing of sick-room floors.—Show why this should be generally avoided as causing dangerous damp evaporations, though every means should be taken for removing dust and dirt.

Conduct of persons attending the sick.—Show that these should be scrupulously clean, cheerful in manner, doing everything quietly and regularly, without noise or hastiness, punctual in giving medicine at the right hours, prompt in removal of all offensive matters, and most particular in the immediate cleansing of all vessels made use of, &c. Point out the unwiseness of any nurse talking too much to the patient, above all on the subject of bad and distressing cases they have attended before; of arguing or losing temper with the sick; of showing that the nursing is regarded as a trouble. Some nurses think they comfort the sick by always talking of their own aches and pains. This is quite wrong; the sick person is naturally weak and selfish, and prefers being the centre of interest.

Mistakes in nursing.—It is often forgotten that no human being can long remain day and night without rest. Ask the children whether they have not heard women say, when sickness has been in their house, 'I was so many weeks without taking my clothes off.' Show that this was certainly of no benefit to the patient, and, besides its uncleanliness, was bad for the nurse. They will often hear that one woman sits up all night with another who has to nurse some one severely ill. Show the folly of this; that

one should *relieve* the other, and allow her to sleep, instead of two persons rendering themselves useless by want of rest. They will know that some nurses let any number of neighbours into the sick room, for the sake of their own gossiping, instead of keeping the sick person as quiet as possible. Show that this may deprive the patient of many short intervals of sleep on which life itself may depend; and warn them against ever breaking a sick person's sleep, even to administer medicine.

Infection.—You cannot too strongly impress the duty of preventing infection by every possible means. Teach the maxim, 'Better to be sure than sorry,' as a text for such precaution. Show that scarlatina of a very slight sort in one person might prove of the deadliest sort in another, as a reason for carefulness even when an epidemic seems of the mildest type. Make them understand further, that once an infectious illness is known to be in a house, persons can be severely fined and punished for the crime of communicating it by carelessness.

Disinfectants.—Tell the children something about the nature and use of Condy's Fluid, and press upon them the value of keeping a shilling bottle in the house.

Contagion.—Warn them especially against this. Show them that infection may be communicated by the air, in spite of all precautions, but that by avoiding contact with diseased persons they may escape a sickness; apply this to the case of playing with children who have lately had scarlatina, &c. As to small-pox there is happily so much terror of its spreading in our country that warning against its dangers is unnecessary.

Isolation of Disease.—Teach your class that, when an infectious disease breaks out, it is *every one's duty* to aid

in its isolation. This is one of many too neglected ways in which even young children can be made conscious of the importance of social politics ; they will feel interested and dignified by being thought capable of really doing something for the good of their neighbours and their country.

CHAPTER V.

DIVISION III. (*continued*).—COTTAGE INCOME AND EXPENDITURE.

Work the source of wealth.—Begin this subject by a set of questions tending to prove the necessity, as a general rule, of work in order to secure existence. Very few of the children before you, of course, will have begun to earn their own living. Ask who has fed, housed, and clothed them. Show how someone at some time must have worked to do this; that this must be even the case of people who have large fortunes.

Meaning of money.—Next lead them to see the first principles of barter, and how its inconveniences naturally led to the use of money. Thus give them a clear notion that money is merely a convenient measure of the plenty or scarcity of commodities. Let them judge that a man cannot eat or drink gold, silver, or copper, but can exchange it for things he can eat or drink. Show them how a man with a bag of coin in his hand might be so poor as to die of starvation in a wilderness, and so on. Show why one metal is dearer than another, because there is less of it, and that, like corn and labour, metals and all other commodities must follow laws of demand and supply. Illustrate this by every-day instances, fluctuations in price of bread and other things, in as many ways as you can, so as to print this main point on every child's mind. Show that coin is a convenient

commodity, as it may easily be exchanged for all other commodities we want.

Expenditure and income.—Take (according to the class in life of children you are teaching, who will all be over Standard IV.) fifteen, twenty, or thirty shillings a week as the available income; let them each write down how they would apportion this, setting down the various items they will suppose necessary, and their presumable prices. This lesson may be made most interesting by reading out a few of the exercises and noting what some children have inserted and some have omitted; (also, after considerable practice, by correcting false estimates of value by the general opinions of the class). The first experiments in such lessons will be very rude, and so much the better; the teacher's main corrections must be pointing out forgotten items, and showing the difference between daily wants (bread, milk, &c.), weekly ones (tea, sugar, school pence, &c.), monthly ones (payments to sick and clothing clubs, &c.), quarterly or yearly ones (such as rent), and occasional ones, such as clothes. Remember they will have a year's time to learn this in; so give them plenty of estimates to make, and, if possible, let them have a separate copy-book for keeping them in. Let them enter what they can judge of the actual expenditure in their own homes in the way of amusements, beer, tobacco, sweetmeats, &c. Of course their entries must not be by mere guess, nor should the teacher always tell them the current price at which to place commodities. Let them inquire for themselves out of school; it will give them notions of value, and they will have a pride in discovering cheap shops and keeping down their estimates. If you accustom them to this, and commend those who find good ways of correcting their companions' estimates by cheapening the prices first assigned, and by cutting off superfluities, you may teach them a great deal of most profitable economy without their handling a shilling.

Necessity of self-denial.—The habit of making such estimates will show the children the necessity of self-denial. They will find, in nearly every case, that the daily and weekly expenditure they set down will prove, when the more occasional necessary charges are added, to exceed the annual income. Show them that, to avoid the danger and pressure of debt, the estimates must be reduced, or the income must be increased. The former alternative reduction of estimate you will teach them to treat first, in a set of lessons showing what are necessaries, and what superfluities, which may be struck out; the latter, means of adding to income, you can make the subject of a set of subsequent lessons.

Necessaries and luxuries.—You will find various items in the estimates made which will suggest much teaching. Tobacco, for instance, you can only teach to be a luxury. Beer, on the other hand, you will find it wisest, whatever your own opinion on the subject, to let them regard as a food. This will not prevent you teaching much as to its uselessness, its enormous cost, its evil effects, and its comparative worthlessness as food, showing how much sound nourishment, good clothing, and additional comfort might be obtained for money misspent in drink. You will find them soon reducing the beer money in their imaginary estimates. They will learn to transfer many other items from the necessary to the luxurious lists, and thus draw nearer to balancing expenditure with income.

Reserve fund.—But allow no estimate to pass your judgment as a good one that does not contrive somehow to secure a reserve fund for unexpected contingencies. Show them the disadvantage of housekeepers never having a shilling to spare—that the least mishap may put them in debt; and always insist on an item of *reserve*. The use of such a sum they will understand better when you come to teach them the duties and rules of providence as well as of thrift.

Expenditure must balance income.—Suppose the income, excluding *all* luxuries, prove insufficient for the estimate made, you must teach them to modify the necessaries charged. Perhaps, for instance, they may have allowed too much for meat, when as much nourishment can easily be got from cheaper things. Showing this will teach them how to economise in the cost of eating. The same may be shown with regard to the use of fuel. If their calculation prove too high for the wages to pay, they must contrive a cheaper and better system of warming; if they have allowed too much for Sunday clothes, they must content themselves with cheaper materials, and so on. But show that they must bring down the estimate to the income, or debt and ruin ensue.

Means of increasing income.—Show how everybody thinks he would be quite happy if he had a little more income than now, and, according as your scholars are in town or country, indicate means of increasing income. Show that daily wage is a market matter, which neither employer nor employed can fix just as he likes; but that profit from extra work or piece work depends on what men will do for themselves. For country children show the increase of income, or saving of expense, amounting to the same thing, which can arise from gardening, pig-keeping, bee-keeping, rabbit-feeding, &c.

How money makes money.—Show that once a man has more money than he needs to spend he is a capitalist, and can get *advantages* with his money. *You cannot enforce this truth too strongly.* Bees, pigs, rabbits, gardening requisites, cannot be got without money; therefore show the necessity of saving, which will bring us on to the subject of *providence.* Dwell most especially on the advantage of a reserve fund as cheapening everything. Let this come out from showing that the poor always have to pay most for what they buy, first because they buy in such small

quantities, and secondly because they do not always pay with ready money; and let them see that a reserve fund of a pound or two would set them free from these great disadvantages. Din this well into their minds, and give them frequent calculations to make of the money to be saved by buying in larger quantities and for ready money. Show how this can be done still better by several joining together part of their reserve funds to lay in cheap stores for ready money, and you will have taught them the grammar and common sense of co-operation.

CHAPTER VI.

DIVISION III. (*continued*).—SAVINGS.[1]

Difference between thrift and providence.—In the last chapter, showing how to teach the art of increasing our comfort of life, either by earning more or by making our earnings go further, we have been studying thrift, or the way to thrive and prosper. A thrifty man may make his earnings keep him in a great deal of comfort so long as he is able to earn. But just such a man will have forethought enough to know that, if he live long enough, his powers of earning must diminish; that there will be times when he will want money and cannot earn it; so, if he be wise, he will go beyond being *thrifty*, he will become *provident*—that is, he will provide for times of need out of his earnings in time of abundance; in other words, he will lay by money.

Duty of providence.—Show your class that every man's *duty* is to make provision against want in sickness and old age, by making it clear to them that if all neglected this duty all would starve. Show next why so many people make no provision, namely, because the Poor Law is in existence to keep them alive when destitute. Let them see the folly of trusting to the poor-rates, by showing that people

[1] Use for class teaching, in this as well as other branches of Domestic Economy, Bartley's *Domestic Economy; Thrift in Every-day Life*; and, as a reading book in your upper standards, *The Thrift and Providence Reading Book*, by the Rev. W. Lewery Blackley, M.A.

on the parish are never happy or contented; that they never have enough to keep them comfortably, and that they get nothing but the very smallest help necessary to keep them alive.

Burial by the parish.—They will all be ready to think it a great disgrace and pity to have to be buried by the parish. Show that the disgrace is far more likely to be felt by a live person in being kept alive by the parish than by a dead person in being buried by it, and so forth.

The literal meaning of 'providence' is looking forward.—Set the class to do this by making each one write down on a slate what he thinks he shall live on when unable to earn money. Whatever answer you receive must come under one or other of these two heads, *independence* or *dependence*. For a man unable to work, unless he have a provision made to keep him, must depend for his living on other people.

True meaning of 'independence.'—Some folk think *independence* means much the same thing as insolence and bad manners. Show this to be a mistake. If a man living on parish pay swear at the relieving officer and abuse the guardians and insult the ratepayers, he is *dependent* all the same on what they give him for a livelihood; while a civil, well-mannered labourer, who has a good provision made by himself against want in sickness and age, does not depend upon the poor rates at all, and is *independent* in the right and happy sense of the word.

Independence better than dependence.—Take great trouble in making the children able to explain this fact. Show how the *independent* man can have in time of need as much as he likes to provide, while the *dependent* man can only have the very least other people choose to give him.

Sponging and beggary.—Show them that there are two kinds of dependence—depending on friends, or sponging, and depending on strangers, or beggary; and try to make them understand the baseness of both.

Possibility of provision.—It is quite possible that many of your pupils, children of classes quite ready to receive parish aid—some of them, moreover, actually having their school fees paid from the rates—will have been taught at home that a proper provision against need in sickness and old age is impossible for working men to make. Put this notion entirely out of their minds. They will see that some men can, if some can not, make provision which will do away with the allegation of universal impossibility. Next try to show them that many who are now too old to provide might have done so when they were younger had they chosen. And on this fact, which you can exemplify by many illustrations, base your constant enforcement of the duty and wisdom of beginning early, even as children, the habit of thrift and providence.

Penny banks.—If there be no penny bank in the school you are engaged in, do your strenuous best to get one established. Any two respectable persons who will devote one quarter of an hour each week to carrying it on will be giving to their neighbours a vast benefit, besides putting before the scholars' eyes a weekly lesson of practical providence.

Get the children to make either occasional or regular deposits, taking care to make them understand the meaning of such terms as *deposit*, *investment*, *trusteeship*, *security*, and *interest*; and fill them with ambition to save up, even from the very earliest, a reserve fund which may help them in every way as they grow older.

Importance of saving to the young.—Make them

understand that all young people, when unmarried and earning wages beyond what they truly need to spend day by day, are *capitalists*, by the surplus of their earnings above their necessities; that youth is the only time in which they can with certainty become capitalists; and that they must be careful to *invest* such capital for the future, instead of wasting it in the present.

Insurance against want in sickness and old age.—Even children will understand that a little laid by every week will not eventually keep a man through many months of sickness, when unable to earn wages. So give them abundance of definite teaching on the great subject of insurance. Having shown them its principles, give them plenty of exercise and calculation on the subject in their arithmetic lessons. These lessons should familiarise them with the meaning of such terms as *average sickness and mortality*, *expectation of life*, *investment of capital*, *proportion of management expenses to income*, and so forth. Such practical arithmetic is far more useful to ninety-nine out of a hundred children than calculations they will never need in angular measure, or in wool and troy weights.

Friendly societies.—You will thus make your children familiar with the outlines of the friendly society system, as a sick and pension fund, or benefit club; and probably teach them enough to make them quite willing and anxious to join some such society as soon as they begin to earn wages.

How to select a friendly society.—It is one thing to make your scholars willing to join a society, and another to teach them how to know safe ones from unsafe. For, unhappily, a vast majority of our so-called friendly societies are unsafe, being based on wrong principles. We can only here point out some conditions which you must

show your pupils to be indispensable to the offering of proper security by any benefit club. It must provide for pension in old age as well as for a weekly payment in sickness, or the member will be only a pauper in old age; it must have not only a government certificate that the rules are according to law, but also *an actuary's* certificate that the contributions are sufficient to secure the benefits promised; it should have a distinct rate of payment at entry for each year (or perhaps three years) of age, so as to secure the young member from having to pay more than his share for the advantage of old members; it should not hold its meetings at a public-house; it should not mix its sick fund with any trade fund, lest the provision for sickness should be lost in supporting a strike for wages; and it should keep its sick fund membership quite apart from any *trade* organisation, which might allow a man to be expelled and lose his sick pay and pension, if he dissented from the doings of his trade committee.

The safest and easiest form of insurance.—This is that of payment in advance. Teach your classes that this secures better than any other form, and at a cheaper rate. A monthly or quarterly payment may be easy in good times, and become impossible in bad times, so that a man may lose the provision altogether to which he has been contributing for years. And, again, if he has made his insurance by one payment, in youth, when his earnings were good and his outgoings small, he will not have to pinch himself or his wife and family all through the rest of his lifetime, in order to 'keep up his club.'

Other means of provision.—Teach your class that money makes money; and urge them to put the statement to the test of practice, even in their young days. The boy or girl who lays up a pound is learning far more than a pound's worth in the habit of self-denial and thrift he or she is forming. We have pointed to the penny bank as the

first beginning; it will save many a shilling from useless lollipops and sweets, to buy good, sound, useful clothing, or sensible toys, or garden tools, or beehives, or even a watch. And when young folks have once got the habit of laying by, and are capitalists, they will have to consider how to invest their money. Therefore give your upper standards plenty of clear information about Government annuities, pensions, and Post Office insurance. They will understand of themselves, if they insure in a good club, that they must keep up membership of a provident dispensary, or, in other words, 'pay in for the doctor,' or else they will get no certificate to entitle them to sick pay.

But, when all these things are done, the truly thrifty and provident man will generally have some money to spare. Therefore teach the meaning and method of building societies, whereby working people can, with a small payment to begin with, buy a bit of ground, and on the security of the ground borrow enough money to build a house, which, after paying off a certain part of the borrowed money each year for a time, they can either sell, or live in, rent free, and have still, when they die, to leave to their children. So from the first beginning of a little child's halfpence placed in the penny bank, to the making of an old man's will and leaving of comfort to his family, you can bring your classes to a knowledge of the history and possibility of independence, while keeping before them, in its true light, the injustice, dishonesty, shame, degradation, and real misery, caused by waste, self-indulgence, thriftlessness, and improvidence, which keep men poor and discontented through life, and make them die as wretched, half-starved lonely paupers at the last.

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DOMESTIC ECONOMY.

SECOND BRANCH.

CHAPTER I.

THE COMPOSITION OF FOOD.

The subject generally.—The Code now recognises, and very wisely, the importance of instruction on the subject of the composition, nutritive value, functions, and proper preparation of food, by making these points a separate division of Domestic Economy, and requiring their study to be a necessary part of every girl's course of that branch of knowledge.

In all specially girls' schools, there will be no practical difficulty in the fulfilment of the Government conditions. Every pupil taking up Domestic Economy at all will be taught and examined in both branches. Nor will there be any difficulty, though there will be disadvantage, in the case of schools for boys only. They will be instructed in the first branch only of Domestic Economy, and the second will be omitted, though very greatly to their loss. For widely useful though the first branch be in teaching them many matters essential to their home comfort, health, and well-being, there can be no question that these things cannot be

sought and gained in any true fulness without knowledge also on the subject of food, on the fitness, the supply, and the preparation of which so very much depends.

The subject should be taught to boys as well as girls.—But in the case of a mixed school another difficulty arises. Boys who are taught Domestic Economy need not, while girls must, take up the second branch; the effect of which distinction would probably be to complicate the time-table, or to discourage the study of the subject altogether. Is there any remedy for this? I think so. Make every part of the subject, in both branches, a matter of instruction *to boys and girls alike.* Let the boys as well as the girls know something of the nature, functions, and even preparation of food; there will be no inequality in their instruction, no trouble in separate teaching, and, as a result, when they grow up and marry, there will be, as a consequence of the fuller teaching, two chances, instead of one, in every household for the putting into wholesome practice those essential principles of health and comfort which can only be fitly inculcated by lessons upon food as well as on all other points of Domestic Economy.

Therefore have no fear or hesitation about teaching the whole subject, in both its branches, to boys as well as girls. There are but few schools in which the preparation of food can be really *practically* taught; and where it is, such a handbook as Mrs. Buckton's 'Food and Home Cookery' will be both valuable and necessary. The *principles*, however, of food preparation are as valuable for boys as for girls, and the former can never be injured by even a considerable knowledge of its practice.

Definition of food.—In its widest sense you may teach your class that everything which tends to sustain life is food; and from this they may gather that food can only be consumed by living things. But you must at once limit

your sense of the term. Show them, if you will, that besides men, beasts, and insects, plants of every sort are living things, and so far under the same conditions with animals as to need food for existence as well as for growth; but then remove these from your sense of the term as applied to our present study, by limiting your meaning to *the food of man.* Thus you may make them see that *the food of man means everything the consumption of which tends to keep human beings alive.*

What is food for?—This, in other words, is the same thing as asking what the functions of food are, which, according to the arrangement of the Code, is relegated to the second year's study of the food subject, and will be treated further on in this manual. But you cannot approach the question of what food is made of (that is, its composition and nutritive value), without giving your class a clear notion of what it is meant to do; since it is plain that we cannot define what is food and what is not without some general notion of the proper function which gives it a claim to be called a food at all.

You must therefore so far encroach upon the later teaching as to show your pupils (as you may, by various simple illustrations) the facts—

Firstly, that a body wears out, and needs supply.
Secondly, that a body grows, and needs substance.
Thirdly, that a body must keep up a certain temperature, and needs fuel; and,
Fourthly, that a body works, and needs power, force or strength.

Stress to be laid on these points.—You cannot take too much trouble in making the children understand this matter thoroughly. For a right sense of this is the foundation of the whole philosophy of food. Give them abundant illustrations of it in every form. As to waste and replacement, show how use

wears out their slate-pencils, which must in time be replaced; how their clothes wear out and must be patched and mended; how houses wear out and have to be replaced by new ones. As to growth and supply you can illustrate these by making them think of the growth (in spite of constant cutting and trimming) of the hair and nails; that this growth seems unceasing, and yet must be supplied from some source or other. As to temperature and fuel, you have the familiar examples of fire, lamp, and candle; and as to work and power, you have the whole range of illustration from the boiling kettle to the steam-engine at your command to give examples of your meaning. Nor need you be content with these; a multitude of other simple illustrations will occur to your mind, which you will really find it worth while to note down in a pocket-book for reference in your preparation and for use in your teaching.

The necessary elements of food.—In the widest sense the food of man may be said to be compounded of substances of two sorts, *carbonaceous* and *nitrogenous*—fuel-forming and flesh-forming. See that *every* child in your class (not just the one or two most attentive ones) is clear about these two words. You may help their memory by writing on the black-board the derivation of *carbonaceous*, the Latin *carbo*, a coal. [Cf. *carbon*, i.e. charcoal.] This will associate the notion of *fuel* with the word in the children's minds. Make them understand clearly that all food is made up of these principles; but show them that some substances may contain both principles, and others only one. For example, there is no nitrogen, or flesh-forming principle, in dripping, lard, butter, treacle, or sugar. Let them learn further that though some of our foods contain no nitrogen, all of them contain some carbon.

Exercises on above.—Write on a black-board the names of some commonly used articles of diet, with their relative contents of carbon and nitrogen. These can be ex-

tracted from the table of Food Constituents on page 83 of Bartley's 'Domestic Economy'; we should print some here, but that we wish you to give many of these exercises to your class, varying some of the foods named on your black-board from time to time. Now make the children understand that *about twenty times more fuel-food is wanted than flesh-forming food*, and let them write down in their books or on slates (the former is preferable, as they may take the books home, and talk on the subject to their parents) their opinion as to the relative feeding value of the different foods cited.

Suppose you give them the following:—

Food	Grs. of carbon per lb.	Grs. of nitrogen per lb.
Indian meal contains . .	3,016	120
Sugar.	2,955	0
Beef	1,854	189
Oatmeal	2,831	136

and ask them (either in the class, or as a home lesson) to find out for you how much excess or deficiency of nitrogen each of these different foods contains. Make them work the proportion of nitrogen required by the carbon to make it into perfect food. If the proportion of 1 to 20 be borne in mind, they can easily add in a third column with + or – sign the proper quantity, thus:—

Food	Grs. of carbon	Grs. of nitrogen	Pro-portion	Difference of nitrogen grs.
Indian meal contains.	3,016	120	150 –	30
Sugar . . .	2,955	0	150 –	150
Beef . . .	1,854	189	92 +	97
Oatmeal . . .	2,831	136	141 –	5

Let them work many examples of this kind, till they are as familiar with the process of finding out the excess or deficiency of nitrogen in any food as they are with working the rule of three. This will make it easy for them to work two other sets of exercises, one on the *comparative values* and the other on the *best combinations* of foods.

Distinction between animal and vegetable foods.—Your pupils thus far will have been taught to consider all foods together, without division into the two great classes of animal and vegetable. Such a table as I have referred to in Mr. Bartley's book does not distinguish these even by position. But it will be well to make the class clearly understand the difference. Many people imagine, until they are taught better, that animal food means meat only, and quite forget that milk, cream, butter, cheese, and eggs are animal food. Many people who call themselves vegetarians eat melted butter with all green vegetables, and many other such mistakes are made. It really, however, does not matter whether we use either animal or vegetable food almost exclusively, or whether we combine them both, provided we secure a proper proportion of the necessary elements of nutrition in the food we eat. A good way of proving this truth to the children will be to suggest the comparison between green vegetables and beef as producing nutrition. They will see that there is vastly more nitrogen in beef than in grass. But ask them what made the beef, and they will say at once that it was the grass eaten by the ox; so that they will see that a sufficiency of nitrogen may, after all, be obtained from green food, if only enough of it be consumed.

Mineral food.—Your class will have learned that carbon and nitrogen are the essentials of food, and a little further on they will learn the common-sense way of combining these two in the least wasteful way. But as you show them that for the making of flesh and supply of fuel these two ingredients are wanted, you must teach them further that *mineral food of some sort, though in very small quantity indeed, is necessary for man.* You may show this by making them consider how necessary we all find a little salt with what we eat, though a great part of our food, in its natural form, already contains a portion of that mineral.

Liquid food.—Besides showing, as you will now have done, the ingredients and the kinds, you will have to put before your pupils the different *forms*, of food. Most of them at first regard only solids as food, but a very little questioning will satisfy them of the importance of liquid food. The fact that infants cannot take any solid food till they obtain their teeth, that men or animals have been known to live for weeks with only water, and that people can exist even for years in good health on no other sustenance than milk, will make this clear.

CHAPTER II.

COMPARATIVE VALUES OF FOODS.

Comparative values of different foods.—When your pupils are thoroughly practised in determining the proportions of carbon and nitrogen in various foods, they may be very easily taught to appreciate in some degree their comparative values. Set them *a great many examples* of such comparisons, drawn from such tables of constituents of food as I have already cited. If the table itself has been copied down by the children in their note-books, it will afford a very easy and interesting reference. Let the comparisons, if possible, be set as home lessons, as by this means the attention of parents will often be brought to the subject, and a step taken towards correcting the enormous waste of money which is caused at present, by entire ignorance as to what food ought to be used, and by common prejudice against trying anything new.

Combination of foods.—When your classes are *well versed*, as you should make them, by constant practice, in the proper constituents and comparative values of different foods, you may ply them with exercises on the best way of *combining* foods together. Thus they will soon learn that carrots and cabbage, for instance, as an accompaniment to boiled beef, is not a mere matter of arbitrary taste, but of good common sense—the deficiency of fuel-food in the beef being compensated by its excess in the vegetables, and the deficiency of flesh-forming food in the vegetables being

compensated by its excess in the beef. Show them by this example that, if they had to live on beef only, they would require to eat twice as much nitrogenous food as they wanted, in order to keep up the necessary warmth of the body; while, if they had nothing but the vegetables to live on, they would have to eat twice as much fuel-food as they wanted, in order to supply the natural waste of tissue; whilst, by combining the two, the necessary amount of each principle would be taken into the system with the smallest amount of waste.

You may, after giving several instances of combining two sorts of food, bring the children on to practise combinations of three or more kinds; from showing them how to balance ingredients at a single meal, you may let them make combinations of ingredients for a whole day's diet—breakfast, dinner, and supper.

Application of these principles.—You may take endless occasions in these lessons, not so much of asserting, as of letting the children work out for themselves, the knowledge of many every-day follies in the choice of diet commonly used amongst us. For instance, with regard to the use of liquid food (which you must also make them combine in the dietaries you teach them to draw up), you can show them the amazing difference in food value between milk, which so few persons think of using, and beer or porter, consumed by so many. Suppose the prices of milk and beer to be the same (averaging fivepence a quart), let them calculate the relative value of each as real food for man. They will see that *a quart of milk has more than twice the fuel value, and forty-four times the flesh-forming value of beer or porter*—a lesson which may do great good not only to the children themselves, but to others to whom they may repeat it.

Errors as to relative values of food.—You must frequently and forcibly put before your pupils the great mis-

takes commonly made in England as to the value of food. Give them the example of bread. Let the children whose parents eat white bread of 'seconds' flour, hold up their hands. Then those whose parents use 'firsts' flour. You will probably find there are ten of the latter to one of the former. Try the same question with regard to brown or white bread. You will be pretty sure to find the same result. Explain to them over and over again the constituent parts of a grain of wheat, till they thoroughly understand it, and see the utter folly of using only the starchy part of the grain, which is contained in the 'firsts' flour, and leaving out what are called the albuminoid materials contained in the various coverings of the grain when it goes to the miller, and all of which are contained in 'seconds' flour.

Different food adapted to different circumstances.—Though I have advised you to teach the importance of a general proportion of say twenty parts of fuel-food to one of nitrogenous, you must not allow your classes to imagine this a hard and fast rule. It is the ordinary average proportion for human beings; but varies considerably according to age, work, and season. Make your pupils understand this by asking what time of year people want warmth most. Of course they will say in winter, therefore they will see that at that season they should take more fuel-food. In the same way they will want more meat, a greater amount of nitrogenous food, when doing very hard work than at a time when they have very little to do, because in the latter case there will not be so much force and tissue used up in labour and requiring to be replaced; and similarly they will understand that children who are growing fast will want a great deal more food to supply the demands of their growth than old people who have done growing and work little.

Limits to nutritive value of various foods.—The question will naturally occur to some of your pupils (even

though they have not the courage to ask you before their companions), why should we not absolutely restrict our diet to some one suitable food. Take the case of oatmeal, which in its supply of necessary food elements is probably the most perfect single article of human consumption to be found. Why should not men live exclusively upon this? The answer is to be found, not in the fact that the food itself will not sustain life effectually, but that if there be too great sameness of food the appetite will not be keen enough to induce people to eat sufficient for the supply of their bodily wants. Of course there are many foods which are continually eaten. For instance, most people can eat bread and potatoes every day of their lives, though they would get very sick of eating plum-pudding, or treacle, or calves' liver, or even partridge, every day for a couple of months. But in general people have better appetite, better digestion, and better health for having variety in their food. If your school be in the country, you can illustrate this by setting them to enquire about the produce of cows in the neighbourhood. They will be told everywhere, if they do not know the fact already, that cows which are led out to feed every day by the wayside hedgerows produce more milk and butter a week than the regular dairyman's cows, which spend weeks at a time on rich pastures; the reason being that on the pastures their diet, though abundant, is all of one sort; while the wayside feeder crops nourishment with an appetite all the better for being tempted by a great number of the different sorts of plants which grow wild, and thus afford a variety and change of diet every day.

Common errors with regard to food.—You may do great eventual good by giving many careful lessons on this subject. You will find that, generally speaking, prejudice is quite as much the source of such errors as ignorance, and you should incidentally make clear the folly of such prejudice. I will give you a case which may explain what I mean. I

had been speaking one day in a cottage as to the entirely unsuspected value of oatmeal porridge as a cheap and wonderfully nourishing and perfect food, when the master of the house said, 'Ah! I could never eat that stuff!' 'Have you ever tasted it?' I asked. 'Not I,' was the reply; 'I'm sure I could never get it up to my mouth!' Urge upon your class the common sense of at least tasting things that are known to be good for food, rather than ignorantly rejecting their use; showing them that many people come in time to be very fond of food which at first they disliked the notion of even looking at, and that it is time enough to refuse to use a wholesome and cheap article of diet, when we have found out that we really dislike its taste.

I have referred elsewhere to the foolish prejudice which leads so many people to use only first flour for bread, thus leaving out all the nitrogenous or flesh-forming qualities of the grain, and only using, at foolish expense, the starchy part. I have found people answer me, when I have shown them that those wasted parts of the wheat were just what men used, instead of flour, to fatten pigs, that they did not see why men should be expected to eat pigs' victuals! The folly of this is plain: the food, if good for a pig's body, is probably good for a man's body, and if the persons who gave the answer were right, they ought to drink no water, because cows and horses drink it too. This is another sort of prejudice which you will endeavour to work out of the minds of your pupils.

The extravagant use of meat.—Try to show how much further wages would go than at present, if people knew how general a mistake is made as to butcher's meat in large quantities being really the best food. Within the last ten years (1870–80) the quantity of meat eaten per head of the population has nearly doubled, and yet men in general are not twice as strong, or twice as healthy, as they used to be. Show that though meat is excellent food, and

desirable to be eaten from time to time to give change and variety of diet, yet its place as a nutritive can be very well supplied by materials which are not much more than a tenth as costly. Point out that multitudes of men who work hard think nothing will keep up their strength but eating meat three, and even four, times a day, and yet others are quite equal to them in the work they do and the strength they possess; and that those who either never eat it at all, or only occasionally, spend a very great deal less in the food they buy without being really worse fed, and therefore have a great deal more money at their disposal, for other purposes of comfort and enjoyment, than those who spend so much in meat.

CHAPTER III.

THE FUNCTIONS OF FOOD.

Why do we need food at all?—We come to the second division of the Food subject—the functions of food, at which I have already slightly hinted in the preceding chapter. Many a person may have said or thought, 'What a convenience it would be if we could do without eating or drinking every day of our lives! How much trouble, and labour, and anxiety it would save us!' But a very little knowledge of the nature of our bodies would show how impossible any such arrangement must be.

For there is a continual waste going on in our bodies by the very bodily effort to remain alive. Make your class understand this. Let them learn to feel their pulses at the wrist, to compare the beating with their heart-beats, and to understand that, even without their choice, their body is doing some work. From this let them understand that when that work stops the body dies; that the existence of pulsation makes the difference between life and death. Next make them understand how everything else in constant use becomes worn, and may become quite worn-out. If they see that this is the case even with hard metals, such as knives, forks, and pokers are made of, which are very difficult to wear away, they will readily believe that soft textures like the linings of all the blood vessels in the body must wear out too if something is always rushing along them, as the blood is, and causing friction (or rubbing) and heat as it goes. Show them how the hand or foot may become blistered, the one by

handling a spade or an axe, the other by rubbing against the leather of a shoe, and how nature, in a wonderful way, supplies new skin to take the place of that which has been worn away by this friction. If this be plain they will see that unless the body were given something in the way of food which, by its own way of working, it could use in repairing its damages and supplying its losses, it would soon be altogether worn away.

This will make them all see at least one good reason why man cannot do without food.

Continuous supply of food necessary.—The next thing to show is that food is constantly necessary to man. Of course, to some extent this is done by showing that as the waste and wear of the frame is continuous, the supply for its repair and replacement must be continuous also. A little questioning on the causes why people stop eating at all—namely, from being unable to eat much at a time—will, however, bring your pupils to see why they are compelled to eat often. You will lead them to a general notion of the need of a continual process of turning food into flesh, fat, fuel, and force, which has to be carried out by the stomach and skin in digesting and assimilating food; and you will show them that this is a laborious process, which can only be carried out on small quantities at a time. You will probably lead them to explain for themselves the result of eating too much; that the stomach naturally rebels against carrying out a task too great for its powers, and refuses to retain this superabundant food.

Having shown that nature refuses overfeeding, show further that it insists upon sufficient feeding; that as it causes a feeling of disgust against even dainty and delicious food when sufficient has been eaten, it also causes a feeling of necessity or craving for even plain food when one has been left long enough without it to have completed the process of digestion.

Appetite for food.—I have said that nature causes

that feeling of desire for food commonly called appetite. A man who knows nothing about the composition of food, or its functions exercised on the human body, understands very well what appetite means. For otherwise he would not exist, since, as a baby, he would not have known how to take food. Thus, if you ask a child in your class why he eats his dinner, he will say, 'Because I am hungry,' not 'Because the human frame requires a regular supply of food to fill up the place of all the wear and tear which is continually going on in the body.' The sense of hunger is the reason why he eats, not the feeling of the necessity of nutrition. But you must not leave this statement concerning appetite without giving some special warning to the children against supposing that appetite is a sensation to be always unhesitatingly yielded to. Suggest to them the common experience of a school-treat, and let them call to mind how many of them who felt quite in want of an additional slice of cake would really not have felt able to swallow a few mouthfuls of dry stale bread, and they will see at once that the feeling of desire to eat may be a bad guide, as leading people to eat more than nature needs, or than can do good to the body. And carry the teaching, if you will, a little further, by telling them (for they will not know it of themselves) that the sense of hunger they experience for food is a feeling exactly the same as a drunkard feels when unable to get drink, or a smoker feels when obliged to do without tobacco; and that the man hungry for food, the drunkard craving for drink, the smoker longing for tobacco, all alike describe their sensation as '*a sort of sinking*.' The great danger of yielding to appetite should be shown to lie, not in the temptation to take too much real food; for nature must have real food, and the taking of a sufficiency of food extinguishes the eater's appetite; but in contracting the habit of indulging false appetites for matters which are not food, such as drink and smoking, the desire for which is not extinguished by supply; so that thoughtless, self-indulgent

men who yield to such habits have no safeguard against excess and that ruin of health and energy which excess is sure to cause them sooner or later.

You may also point out that the habit of yielding to an appetite for even apparently harmless things, such as cold water, can grow on people very rapidly; while by disciplining and overcoming our appetites as a matter of duty, we find our wants the fewer, our bodies the healthier, and our lives the easier.

The ingredients of which food should consist. —Knowing that the functions of food are to supply the body, you will find it will help you if you show what ingredients form the body, and consequently what ingredients should be looked for in food. Our bodies, then, you will show, are made up of different matters in different proportions. If nine-tenths of our bodies consist of water, for instance, the children will easily understand that the same proportion of water to other food would not unreasonably be taken. Yet, unless you explain this, they will not believe your statement. They will say, 'If all the other food we take in a day be supposed to fill a quart measure, we are quite sure that none of us drink nine quarts of water in a day.' Give them, therefore, several simple proofs that every food they swallow contains water in more or less degree. Let them weigh a large potato, for instance, and write down the exact weight, and then, after letting it bake without burning, in the ashes or in the oven, for several hours, let them weigh it again, and mark the difference; then set them thinking where the lost weight has gone, and in what form they will find it has really been evaporated, that it has disappeared in the form of water, which must therefore have been in the potato before baking. You may even let them prove the matter to their eyesight, by pulling asunder a new-baked loaf of bread, and seeing how the steam goes out from each portion. This, however, is only in passing. The point to be shown

is the quantity of water taken in the food in proportion to the amount of water in the body to be fed. This water, as we shall see further on, is wanted in great proportion both to supply the process of food-preparation, first in the mouth and then in the stomach, and also to present all the food in its liquid and digested form to those organs of the body which are to take the different parts of such food and turn them to special uses.

Substances necessary in nitrogenous food.—Before now you will have been teaching your class in general terms the two forms of food; that it must consist partly of nitrogenous, or flesh-forming, and partly of carbonaceous, or fuel-forming elements. Let them now learn to distinguish and explain the different substances wanted by the body in nitrogenous food. Make them familiar with the meaning of *gelatine*, *fibrine*, *casein*, and *albumen*, and exercise them as far as their intelligence will allow on the combination of these things in the structure of their bodies. Give them, for instance, a notion that in order to supply bone in the body, food must be taken which combines gelatine and fibrine, as well as some such mineral component as lime, for example. If this be wanting, let them understand that a child's bones will not harden, and illustrate this statement by showing how when hens lay what are called 'soft eggs,' their owners supply them with lime or chalk in their food, with the result of hardening the shells of the eggs they lay.

Nitrogenous substances not contained in animal food only.—It may seem almost unnecessary to advise your putting this point before the children; but mistake concerning it is so common that it must be corrected. You can explain, for instance, how the *fibrine*, or fibre contained in meat, is represented by what is called the *gluten* in wheat, and that all the various characters to be found in animal are also to be found, under one or another varying form, in vege-

table matters as well. Make the children comprehend how this may and must be, by considering that the meat of animals which we eat must have been made of the vegetable matters which fed and fattened them.

Substances necessary in carbonaceous food.—Much in the same way that you have taught the substances contained in the nitrogenous parts of food you will make your class clear upon those contained in the carbonaceous parts. Because you have taught them that sugar, gum, oil, fat, and starch are to be found in carbonaceous food, it will not at all follow that they will keep in mind a clear distinction between the two principles. Therefore I should recommend your giving them frequent exercises, either on slate or paper, in separating foods, the composition of which you may dictate to them, into their respective nitrogenous and carbonaceous parts. For, remember, these subjects require the use of many words, especially difficult to young minds, and therefore no means should be left neglected of helping their memory by constant repetition, and their thoughts by constant intelligent exercise and questioning.

Illustrations of effects of diet.—More especially in relation to the substances of our food you may give illustrations of its effects on structure. A horse, if doing much work, may sometimes, for instance, look very thin and bony, though eating a great deal of nitrogenous food; his owner will remedy this, if he wants the horse to look well, by adding some bran to his oats. The same sort of thing is done in order to make animals fat enough for market. Food containing more carbonaceous elements than the body wants for fuel and force is given. Nature stores this up in the form of fat. If men eat too large a proportion of fatty or fuel-forming compared with flesh-forming food, they will grow fat; and some will grow very much too fat, because the more their fat increases the less exercise they are able to

take to work off the fuel in breath and perspiration and use of tissue. Very many people whose great fatness is a trouble and worry to them might have it much reduced by leaving off the use of more or less fuel-food, it being perfectly plain that they are in the habit of consuming a great deal more than nature is able to get rid of in her work. An illustration of this you may give in the case of a steam-vessel. Suppose the vessel made to carry 2,000 tons, that she has boilers that require ten tons of coals a day, and can use no more, and that she makes a complete voyage every ten days, using 100 tons. If she take on board for each voyage 200 tons, she will have too much coal on board, the excess increasing by 100 tons each voyage. In twenty voyages she will be useless, for all her space will be filled up with excess of fuel. The remedy for this would be, after the first voyage, to take in only the quantity of coal really necessary for the voyage. The remedy for the over-fat body is to cease taking in more fuel-food than the body needs.

On the other hand, the children may be interested in some illustrations showing how great quantities of fuel-food may be quite necessary. The furnace of the human body must be kept alight, of course, or we die, since a certain amount of heat must be generated to allow us to live. Now ask them what time of year most fuel is wanted to keep the house warm. They will name winter, the very time we all want more fuel-food. Tell them, what is quite true, that nearly everybody is fatter in summer than in winter, probably because they make very little change in their diet; and, tell them further, that in Northern climates, in the north of Russia, Greenland, Kamskatcha, and such regions, where there is hardly any winter sunshine at all, and a great lack of heat and warmth, nature requires so much more fuel-food than is needed here, that many of the people have to drink oil and live almost altogether on fat to keep themselves alive.

CHAPTER IV.

THE MANNER IN WHICH THE FUNCTIONS OF FOOD ARE PERFORMED.

The process of digestion.[1]—You must give your class some idea of this, which is at the bottom of all theories of food, either in its functions or its preparation. To understand this they must learn what different things make up the body, whose constant waste must be supplied. They will thus get a notion of the various substances which enter into the necessary composition of food. Knowledge on the subject of digestion naturally springs from the following consideration:—

How food performs its functions.—Of course, you will feel that your class must be taught a great deal more about the sustenance of life by food than the fact that it supplies tissue, fuel, and force. You will desire to teach, not merely that food does certain work under certain circumstances, but also how and why the work is done. To show a child a lump of coal, and say, 'That takes our soldiers to India, and fetches our tea from China, and brings our friends to the station,' would be of little use in giving the child knowledge, unless you showed him how such work was,

[1] The hints contained in this chapter on the subject of Digestion are limited to that part of digestion over which we ourselves have any real power (as, for instance, in the way of mastication). It has seemed better to leave the fuller treatment of the further processes of assimilation of food to be dealt with under the head of Physiology.

not indeed done, but assisted, by the use of coal. To say, as you give a child a piece of sugar, 'This will supply warmth to your body,' will certainly not be true if the child only keep the sugar in his hand, and therefore you must not be content to state, but also to explain, the functions of food to your class. The necessity for doing this suggests itself at the first mention of the word 'digestion.' You see you will have to explain the various steps of a long succession of processes. Suppose you put a piece of ice, a piece of sugar, and a spoonful of tea into a cup before your class, and ask them whether they will call that a cup of tea. If they say Yes, ask them to drink it; they will see it cannot be done. If they say No, ask them why not, and you will have set them on the plain way to understand the process of digestion. Make them point out what must be done with such ingredients as I have named, and they will show you that the sugar must be decomposed, the ice must be melted, the tea must be softened and infused, before the ingredients can become drinkable at all, or fit to begin their course of supplying food or nourishment to man.

The first stage of digestion.—The foregoing illustration will have shown your class that in order that the body may obtain all the different parts of its food in a form likely to do it good, the food must be separated into various parts; that the crystals of sugar, for instance, combined with each other in the lump, must become separated in order to enter into new combinations with portions of our bodies. The very beginning of this process you will be able to point out as the act of *tasting*. Let the children, for instance, apply a piece of soda and a piece of stone to their tongues, with their eyes shut. You will find they will all be able to tell the difference between the two things. They will tell you the soda had a taste, but the stone had none. Set them on explaining this to themselves. The touching of their tongue, which is always wet for the pur-

pose, really melts away some of the soda, but melts away none of the stone; and it is the part that is melted and remains in the mouth which they actually taste. If the tongue were *perfectly* dry, and not provided with moisture to melt what was put on it, we could no more taste with it than with our knuckles (though of course the moistening of our knuckles, though it would help them to decompose soda, would not give us the means of tasting it). Thus the children will see that we cannot taste food without thereby beginning the process of digestion of that food.

Saliva and its use.—This will suggest a little teaching on the nature and supply of saliva, and give you an opportunity of illustrating, in passing, the action of the mind upon the body. Stop your class an instant, tell the children to swallow down their saliva, or spittle, and ask them after a few moments whether their mouths be dry. They will answer No; for the very thought of the thing will have brought a fresh supply of saliva rushing through what are called the salivary ducts from the salivary glands into their mouths. Show them that, though, if thinking of the matter, this supply becomes so copious that they will not be able to spend a minute without wanting to swallow down its excess, yet, when not thinking of it, they may sleep seven or eight hours without requiring to swallow at all.

Ask them again where this water comes from that is so necessary to all digestion, and is so abundantly supplied, and show that it must come from the food and drink which we take, through the very process of digestion to which it is so indispensable.

Why it is necessary.—The illustration of the lump of sugar will help you here. If the mouth were dry, and a lump of sugar were placed in it, the sugar could not get down into the human stomach. How do we set about melting a lump of sugar? By pouring water upon it. This is just what

nature does. And how do we do this most quickly. The children will answer, by using hot water; and you can show them that this is nature's process too. Go further, and ask, if they want to melt a pound of sugar, and have only poured on an ounce of water, what would they do? They will say 'fetch more water;' and this is nature's plan again; according as the mouthful to be digested is more or less dry, the salivary glands will send at once more or less saliva to the mouth. This also is a reason why eating and drinking generally go together with us, and that the drier our food and the more saliva it requires to soften it for swallowing, the more we seem to feel the want of a draught of tea, coffee, milk, or water, to help it down.

Thus the children will learn that nature expects everything of food kind which we swallow to be swallowed in a moist state. Now ask them why, and lead them to two reasons for this. These will be, firstly, because what is called our mucous membrane (that is, the moist skin that covers us inside, just as the ordinary skin covers us outside) is so tender as to be very easily scratched and wounded, and that we might be very seriously injured by swallowing down hard, rough substances. This will bring you to the second reason for moistening what we swallow, namely, that we should not give a delicate organ like the stomach, on the health and strength of which our very life depends, an unnecessary amount of work, by making it do what might be so easily done for it in carrying on the first processes of digestion. Show them as an illustration that to give the stomach entirely unprepared things to digest, would be like expecting a baker not only to mix and knead and bake his flour into bread, but also to sow and reap and thrash and grind the wheat from which the flour is made.

Saliva not entirely water.—Before you leave the subject of saliva you may teach your class that it does not altogether consist of water, but that it holds in solution a

portion of muriate of potash, which acts upon the food with a certain amount of digestive power. In passing, you may incidentally hint at the injury and weakening of the system which may result from the very useless and disgusting trick of spitting, which so many people thoughtlessly contract. They may also be taught that the saliva of infants, before they cut their teeth, is not of the sort it afterwards becomes, and is only capable of digesting milk, so that very great harm is often done by feeding young infants on other substances. Bread, as we have seen, generally contains starch, which the saliva of a baby cannot digest as that of an older child would; and so the little creature, though taking food, may not be taking nourishment, and may actually starve to death, as in fact very many do.

Meaning of the word 'secretion.'—The calling the children's attention to the supply of saliva by the salivary glands will give you occasion to explain, what may otherwise confuse them, the meaning of the word *secretion*. Its common use nowadays is in the sense of *hiding away*, but in its first and proper use it has the sense of *separating*. Thus you will explain to them that we have a number of organs in our body which *separate*, or take out, from the mass of our food, the ingredients for making various different liquids necessary for carrying on natural functions. From our meat and drink the salivary glands *secrete* or take out saliva; the lachrymal glands *secrete* tears, to keep our eyes moist and unhurt by the friction of the eyelids; the liver *secretes* bile, to help the digestion of our food. You may illustrate this by letting them consider that all these different organs treat our digested food just as a number of letter-carriers do the contents of a mail-bag when emptied out before them; each takes what belongs to his own district, and *separates* it from the rest for its own especial purpose.

The surplus of our food.—Carry your illustration a little further. Suppose the letter-carriers find a number of

papers and letters not belonging to their district; it is somebody's business to carry them away, and try to turn them to proper use. Just so let the children see that, after all the organs have taken out and separated the different ingredients wanted to carry on our life, to supply waste, and warmth, and force, nature makes it her business to cast out and get rid of all the remaining ingredients. For instance, as they have seen that a vastly larger quantity of water is necessary to enable us to swallow down any solid food, than is required for supplying waste, warmth, and force, nature is continually casting out quantities of water from the body by the breath, by perspiration through the skin, and otherwise.

Importance of mastication.—If the supply of saliva have one particular work to do, in softening food before its reception into the stomach, the children will understand that the supply of teeth in the mouth is provided for another function, that namely of separating and dividing food into parts conveniently small. And here you have really an important lesson to give. The supply of saliva is involuntary—it comes of itself, according as it is wanted, and in just sufficient quantity; but you must point out that though mastication is so far involuntary that a man cannot swallow solid food without masticating, it is his convenience and choice, not the absolute necessity of his nature, which regulates his masticating much or little. Try to impress upon the children the value, to their whole future health, of the habit of eating slowly and of masticating thoroughly. Suggest to them to try whether doing this will not greatly increase even the physical pleasure they have in eating things they like, by gratifying for a longer time the nerves of taste which lead them to the choice of agreeable food. And as this seems rather a sensual basis on which to place your teaching, show them how such a habit will be likely to keep them free from all the suffering so many people undergo, at least in later years, from weak and faulty digestion; which generally

results from their having habitually, by the neglect of perfect mastication, given the stomach too much work to do, and so worn-out and exhausted its best powers.

Advantage of warm food.—Another practical point, on which you may lay stress, is the advantage to easy digestion of food being taken warm. Show that the warmth in the food helps the furnace of the body without enforcing so much expenditure of fuel, in the same way that a shovelful of live coals added to an ordinary fire increases its heat. Thus we find nearly all persons accustomed to swallowing a great part of what they drink warm, in the form of tea or coffee, and finding it much better, and, as they think, much more nourishing, than cold water; the fact being that the tea and coffee contain very little nutrition at all, but the heat they contribute to the body takes the place of nutriment, which otherwise would be expended in producing the same amount of heat.

Effect of cold on digestion.—From the last paragraph you will be able to explain why very cold things taken into the stomach should obstruct and stop the process of digestion. The eating of ice has directly this effect; it takes away from the stock of vital heat, and retards the decomposition of food in the stomach. Illustrate this again by the slowness with which a lump of sugar will dissolve when put into a tumbler of iced water, as compared with a lump placed in a tumbler of boiling water.

These instances will probably suffice to make the children comprehend how great an economy of vital force and energy is effected by the use of warm food and liquids as compared with cold ones; but you may further illustrate it by the analogy of the greater hunger being felt, and the greater quantity of food being required, by persons suffering from cold in winter than by others who spend their time in warm and comfortable rooms; and, once more, by the fact,

that because people receive far more warmth from the atmosphere in summer than in winter, they are less hungry in the warmer season, wear less clothes to keep up their vital heat, and yet almost always, as I have before reminded you, increase in weight in the summer, while they eat more food, wear more clothes, and yet decrease in weight during the winter season.

CHAPTER V.

THE PREPARATION OF FOOD.

Preparation of food as distinct from cooking.— The Code separates these two things, in terms, for convenience' sake, and you had better adopt the same plan with your class. Point out to your pupils that though there are many things eaten without being cooked, but very few are eaten without some preparation. Ask them for examples of things which we eat uncooked. They will say milk, cheese, butter, and perhaps many other things which can be used without actual cooking by the kitchen fire; but, after all, you will find them name very few things, except perhaps raw fruit and shell fish, which are eaten without being specially prepared.

You can very profitably spend part of the time devoted to this subject in teaching them the modes of preparation necessary for many of the articles they most commonly use. For instance, many a town child has no idea of how butter is made from the milk of cows, and many country children even know nothing of the manufacture of cheese. These are, of course, every-day instances, but a teacher can think of many more, the citation of which will increase the pupils' knowledge and stock of ideas.

A great number of processes may be made plain to them. The growth and preparation of mustard, pepper; the making of vinegar; the processes of distillation, brewing, baking; the winning of salt, with many interesting details as to its comparative value at different times and in different places; the preparation of cacao; the salting and pickling of meat;

the method of tinning and preserving fish and food of all sorts; the means of detecting adulteration in common articles of food, will all be found matters of interest to your classes.

Preparation of food for cooking.—This is another branch of the subject, however. The preparation of some substances for food is independent of cooking; but many others require a special and immediate preparation before subjecting them to the fire at all. Instances of these of course are at hand. Vegetables must be carefully cleaned, peas and beans must be taken from the pod, carrots, parsnips, and turnips must be scraped, rabbits skinned, fowls plucked, salted meat soaked to dilute away excess of salt, and so forth. All these are matters of detail, which can be taught in a very short time by practice where cookery classes are established, but concerning which very little can really be done in common oral lessons. One or two points, however, should be insisted on as indispensable maxims; such are the washing of all food before cooking, and the paramount importance of constant and scrupulous cleansing of every cooking utensil as soon as possible after use. For this purpose chiefly a good supply of water, not merely warm, but boiling, should be insisted on as of great importance even in the poorest cottage; and the children should be taught, if there be no boiler, the economy in the end of spending a little more money on a large and strong kettle rather than less money on a small one. The feeling of having but little hot water to spare will often induce housekeepers to leave their utensils without proper cleansing. Ask the children why this cleansing should be even more strictly attended to in a small house or lodging than in a large one. They will see that where the utensils are fewer they are each used for a greater number of different purposes; also that where space is small and fresh air limited, the smell of ill-cleaned cooking vessels is more likely to prove injurious than where room and ventilation are greater.

Marketing, and purchase of food.—Another matter connected with food preparation, but distinct from cooking, is the knowledge how to provide the best food at the cheapest rates. The exercises suggested in my former little volume, 'How to teach Domestic Economy, First Branch,' will have given the children some practical aid towards studying these points. A knowledge of how to buy things cheaply is of great, almost untold, value. Urge on the children, especially if in towns, where shops are many and the matter easy, to make estimates of expenditure from the prices they see advertised. They will see that sometimes certain matters of food are much cheaper than others; they should be taught that, when they try to keep house, such occasional cheapness should be taken advantage of. For instance, one day a fresh herring can be got nowhere under a penny; but the next, there may have been a glut in the market, and they may be bought for sixpence a dozen, or less. Show the children that in such a case a housewife who knew enough simple cooking to 'pot herrings,' as it is called, might prepare a quantity of good food at a very small price, which would give pleasant variety to other foods for ten days or a fortnight. A number of similar instances might be put before the children, and they might be encouraged (if your managers will sanction it) by promises of small rewards at the end of the half-year, to compete in drawing up marketing bills and housekeeping estimates, at the actual prices current on the dates on which the competitions were given out. This sort of thing, if set before the children as an amusing game, in the way of 'playing at housekeeping,' might lay the foundation of great practical skill in many of them. Another point to be attended to is how to keep food fresh—a matter attended with great difficulty in town districts, where several families occupy the same house, each family living only in one or two rooms; and where such a thing as a larder is unknown. Show how much of this difficulty may be obviated by a little meat-safe, its sides made of wire or perforated zinc,

being hung out of window by a cord and pulley. If made with a double shelf, or divided into two compartments, such a contrivance will preserve both meat and milk.

For the rest, as regards the preparation of food for cooking, many valuable rules will be found in various manuals on the subject, some at least of which the teacher is presumed to be familiar with. The hints I have inserted here on the subject are only meant as illustrations and samples of the method a teacher may follow in awakening, and, if possible, in keeping awake, the interest of his pupils on the subject.

CHAPTER VI.

THE CULINARY TREATMENT OF FOOD.

Importance of knowledge of cooking.—From what you have taught already as to the duty of giving as little un necessary toil as possible to an organ so delicate and important as the stomach; as well as from your demonstration that every morsel we put into our mouths is immediately set to work upon by nature in order to send it down, if possible, in a moistened and simplified condition, the children will recognise of themselves that the true object of good cooking is the assistance of digestion, and that the more carefully this is done the more real good will be derived to the body from the food taken, and the more healthy will the bodily functions be.

Beyond this, however, they should be often reminded how much injury and sickness is caused by bad cookery, to say nothing of the money waste caused by the spoiling of food. It is, of course, entirely beyond the scope of such a little manual as the present to offer receipts for the production of various dishes, or, indeed, to do anything beyond offering such suggestions as may prove useful in directing the teacher's attention towards some points which should be made clear to those he teaches, and which might otherwise escape his notice. I have already referred with approval to Mrs. Buckton's book on 'Food and Home Cookery,' and to Mr. Bartley's 'Domestic Economy,' which contains a great many suggestions of the highest value. And these are by no means the only handbooks likely to be of value to both

teachers and scholars. But I would urge teachers, as far as they can, to induce their managers to offer as prizes, more especially in the food branch of domestic economy, some of the many good cookery books specially adapted for cottage conditions, and to be had at a very moderate cost.

Desirability of practical teaching.—But there is probably nothing harder to teach by mere telling than the art of cookery. It is something in itself so entirely practical, that without a fire-place, the necessary utensils, and ingredients of food to use before the pupils' eyes, and to let them handle and practise upon, but a very small progress can be made. There is an old saying, 'An ounce of practice is worth a ton of precept,' and so it is with the teaching of cookery. Arrangements are now sanctioned by the Education Department by which the girls in town schools can receive systematic instruction in this most useful art, and nothing can be more useful as a manual for its teaching than the little book by Mrs. Buckton, 'Food and Home Cookery' (London, Longmans), which contains a number of practical lectures on the subject.

Difficulties in teaching practical cookery in country schools.—In towns it is easy to provide such instruction, because a number of girls from various schools can be brought together at different centres; a thing quite impracticable in the country. Unless the teacher of a country school be, if a woman, skilful in her own little kitchen, or, if a man, have a wife who knows something of practical cookery, I fear there is little prospect of giving practical teaching.

But though practice is better than theory, we must remember that theory may be, and is, a good thing in itself, and we must endeavour, as far as possible, to make the children know some of the principles of good cooking, even though they may not have opportunities of putting them into practice.

The fire for cooking.—Fire, of course, is a first essential for cooking, and the children should be given some notion of how it should be managed. The ordinary fire-places in poor people's dwellings are apt to cook worse, and to waste more, than those of any other country than our own. Try to impress upon the children the advantages of, we will say, the American 'Gem' cooking stoves, both for warming the dwelling and preparing food. A difficulty, however, arises in this, that even a picture will not explain to them these advantages in any way that they can clearly understand. If your school managers could be induced to place one of these stoves in a cottage for a time, say through one winter, or even in the schoolroom, so that its parts and the manner of its employment could be shown, though it might not make many villagers buy one, it would convince many of the children that, when they grew up and were taking a house of their own, they would do best to procure such a one, both for comfort, effectiveness, and cheapness in consuming fuel, rather than any of our ordinary extravagant grates.

The best to be made of present conditions.—Desirable though it be, however, both for ease of teaching and for demonstration of comparative usefulness, that such a stove should be available for the instruction in cookery, it would of course be an absolute folly to let the teaching wait till a general improvement in fire-places had taken place. Therefore let the teacher try to master the conditions of such fire-places as the children under instruction have to use, and instruct them how best to overcome their disadvantages. For this purpose some handbook on heating should be consulted, and the subjects of draughts of air, combustion, and ventilation looked into. A practically useful thing would be for the teacher to take an opportunity (if in the country, not on a market day, when shop-folks are very busy), to go to some large ironmongery store and ask to be shown stoves,

grates, ranges, &c., of different sorts, and to have their differences explained by the shopman. Ten minutes spent in this manner will prove more valuable than hours of description.

The cooking-fire.—Of course all your pupils will agree that a clear red fire is the sort desired for nearly all cooking operations. Set your class on stating how they would secure this. Suppose it be desired to broil some meat over the fire, ask them what the result will be if fresh coal be applied just before the gridiron is set on. They will, of course, answer that the meat will be smoked and spoiled. Ask them again what the result is likely to be if the fire be blazing high when the gridiron is put on. They will answer that the meat will be actually burnt black. This will lead them to see that to cook well the fire ought to be prepared some time beforehand, so that, instead of blazing or flaming, it may be easily brought into a clear state when the cooking begins.

We will suppose that it is desired to cook food so as to have it ready to eat at one o'clock. Suppose the fire to have been lighted so as to boil water for breakfast at eight o'clock, and that it is desirable to waste as little fuel as possible in cooking both meals. Ask the children to advise whether the morning fire should be let go out or be kept up the whole intermediate time; that is, we will say, from eight to eleven o'clock, when the dinner-cooking begins. Most of them will advise its being let out and lighted a second time; and yet this in most cases would be a mistake. Show that by letting the fire go out the grate would probably be cold by nine o'clock, and that to make it as hot as it had been again by eleven would take a new supply of paper, sticks, and coals; and that, in order to get the second fire at all into a fit state for cooking, both time and trouble would have to be spent on blowing it, with the result of wasting much fuel, by blowing away a great deal of it up the chimney,

in the form of unconsumed smoke. Perhaps some intelligent child may say, 'Even that would cost less than keeping the fire up at a blaze the whole morning;' and the child would be right. This will, however, give you the opportunity of showing that neither of these things need be done, by explaining the principle of slow combustion, and making them understand how most of the heat got up in the breakfast fire may be preserved and kept waiting, without loss, till the time comes to begin the cooking of dinner.

On what does combustion depend?—On the amount of air supplied. You can make this plain to them in many ways. The action of the blowpipe, as exhibited in the common bellows, will illustrate it perfectly. Show them that all the fuel in the world will not burn without air. That if a coal-mine take fire, the conflagration is checked by shutting up the pits so as to cut off all supply of air. You may show the same thing by covering, more or less completely, a lighted candle with a tumbler. Exactly the same principle, you can show, is applied in limiting the combustion in the fire. If less air be allowed to get to the fuel, it will burn far more slowly. Therefore by covering over the top of the fire, so that very little air can pass through it, the fuel will be checked in its rapid combustion, and kept hot and ready, when the air is again allowed free course through it, to burn up brightly and clearly. Thus they will learn why the cheapest plan of managing the cooking-fire is to give it much air when cooking is wanted, and to diminish the supply of air when the cooking is done.

But how is this to be done?—In the American kitcheners this is quite simple. A door is drawn across the front of the fire, which prevents all air passing into it or through it from beneath; but lest it should, if quite deprived of air, go out altogether, the air is allowed to pass over the *top* of it, which just keeps it alight, with the smallest possible

combustion of fuel. Show how in our common English fireplaces the same thing can be done, but in a more troublesome way, by what is called making-up, or 'slacking,' the fire.

'Making-up' and 'slacking.'—Most children will have seen the former done. It consists in covering up the fire with the ashes from below the grate, which to a great extent prevent the passage of air through the fire and make the combustion slow. 'Slacking' you will show to be the same process, but done with a quantity of dust-coal (otherwise very hard to make use of) wetted with water, mixed like thick mortar, and laid thickly over the top of the fire. Let the children explain how a 'made-up' fire remains alight. It will be by aid of the air which passes the front of it, in the same way as the closed kitchener-fire is kept alight by the air which passes over the top. As the water in the case of a 'slacked' fire may tend to put it out, they will understand that the combustion must not be made too slow, and that therefore a hole should be made with the poker through the 'slack' into the fire, so as to allow a very small current of air to pass through.

Advantage of 'slacked' over 'made-up' fire.—The children will think at first there is none. Lead them to reflect that the ashes used in 'making-up' a fire can give no heat, while the otherwise useless coal-dust, with which the fire is 'slacked,' dries into a hard cake, which, when broken up, being already heated through, will burn clear and bright for cooking purposes much sooner than any fresh cold lumps of coal, much of which will have to go up the chimney in smoke before the rest burns red and clear in the grate.

Utensils for cooking.—In ordinary schools care should be taken, where practical cooking lessons are given, to limit the number of different utensils employed pretty nearly to those available in ordinary dwellings. It is not merely as

a matter of economy in first cost that this point should be attended to, for it might be supposed that, though ten saucepans would cost twice as much as five, they would be likely to last twice as long. But teachers should keep in mind that in a labourer's cottage, and still more in an artisan's often very crowded lodging in town, space is very limited, and its requirements must be carefully kept in mind.

You will find in most of the manuals quite an alarming list of various utensils required for school cookery, and I cannot but think this a mistake. Mrs. Buckton's excellent book, 'Food and Home Cookery,' has this considerable drawback. The lessons she describes are given by means of an apparatus, contrived of course with special reference to economy of space, but occupying a space of about seven feet in height and width and two feet in depth. Of course no such cupboard as contains her apparatus is required in a cottage, but still the space required by its contents would be as large. One argument, however, in her favour is that if the children be trained by the use of the best utensils to cook food well, they will adapt their knowledge to the less favourable circumstances of their homes in after-life.

Get the children to name, from home experience, all the kitchen utensils they can think of. It will interest them much to give them five minutes to write down the names of all these. When finished, ask who has put down the greatest number, and let the list be read out. The other children can mark in their lists any additional articles not mentioned by themselves, and the list be thus supplemented. You will, as a fact, find a very small number of cooking utensils included.

Importance of supply of hot water.—This cannot be over-valued in the practice of cookery. Point out its advantages, and how great a hindrance and delay the want of hot water may be in preparing food. Let the children enumerate the different matters it may be wanted for in

cooking a meal. This will be a means of showing them the advantage of a good boiler attached to their fire-place, or if not forming a part of it, always kept in any case moderately warm. You may also show that a small quantity of water extremely hot is far more useful, and less troublesome to carry about, than a large quantity containing less heat.

Different processes of cooking.—Ask questions upon these, and see what child can name the greatest number, describing the utensils required for each. The vast majority of them will name first the particular instrument which is absolutely the worst of all for preparing the food of man, and thus show in a moment how greatly the teaching of proper principles of cookery is wanted. For the frying-pan is certainly the most general, in thousands of cases the only, utensil in which meat is cooked.

One instrument you will find hardly any of them think of, the want of which is the source of a great deal of waste among the poor. This is a scale and weights. It would amuse the children if, having shown them a pair, you explained the principle of the balance in a brief way, and suggested to them to try and contrive a set of scales for themselves. All that is needed is a piece of stick, and two or three yards of twine, and for the scales a couple of the little tin plates, not costing more than a penny, to be found in most cottages, with the letters of the alphabet printed round the edges. Let them guess means of supplying weights. These are easily contrived, either by a little patience in trying single pebbles till they find one exactly fitting each standard weight, which you may lend them for a few minutes to try with, or by rubbing down pieces of brick to the proper size. Pebbles are best for this purpose, as not absorbing water and changing in weight in the same way as bricks must in wet weather. Small gravel put up in little bags will answer the purpose well, the weight each bag represents being written on the outside. Childish though it may sound, the setting poor

children to play at shop with a rude apparatus like this, may teach them a very valuable point of domestic economy.

Different processes of cooking meat.—The utensils the children name will suggest the processes in which they are used. The frying-pan to fry; the gridiron to grill or broil; the pot to boil; the stewpan, or saucepan, to stew; the oven to bake. You will find very few of them who will include in their catalogue any contrivance for roasting.

Frying.—Though, as we have hinted, the frying of food, generally speaking, is by no means the most wholesome or economical way of preparing it, it will be plain to the children that there must be some reason why it should be so universally employed as it is. Set them to think of the reasons. They will be of this sort. The process is rapid; it does not involve as much trouble as in the basting of roast meat, or in the frequent turning of meat on the grill; nor so much fuel as is necessary for carrying on all the longer processes of cookery. And there is another reason, namely, that poor people, for the most part, are accustomed to cook only a small quantity of meat at a time, have but little time to devote to its preparation, and are glad to use as little fuel as they can.

Treatment of other processes.—You can take the different processes one by one, and make the children think out the different advantages and disadvantages attending each of them. If, for instance, you show that the effect of frying a piece of meat is to soak it with burnt fat, and thus to supply the stomach with a matter difficult of digestion, you can show the comparative advantage of the grill or gridiron, which, by letting the fire first slightly harden the outside of the meat, keeps in the juices, which in the pan are either lost, or mixed with fat, and likely to cause indiges-

tion. In passing you can suggest occasionally a valuable hint to the children. Ask if they know any one complaining of indigestion; some of them certainly will. Suggest that if they tried for awhile some other way of cooking than the frying-pan they might be better, and so forth.

You will find the relative values of the various processes set forth in nearly all the food and cookery manuals, and their study will properly occupy a large part of the time to be given to this branch of the subject. The main object to keep in view is to make the children *think*, and, as far as possible, instead of laying down maxims first, to induce them, in answering a number of apparently simple and obvious questions, to come, as if by the natural process of their own thought, to understand and adopt the maxims you wish to inculcate. In the same way a child will be more apt to have an intelligent knowledge of the distance between Hyde Park Corner and Chiswick by having walked it in pleasant company one fine day, than by having heard it read out by some one from a list of cab-fares.

Importance of the stewpan, and of the stockpot.—But there are two matters of the utmost value to the poor in the way of cookery which are the most universally neglected in our country. The one is the art of stewing, the other the value of soup. 'Gather up the fragments that remain, that nothing be lost,' are words implying an actual duty which is too little attended to. The stewpan will take in all sorts of food, and accomplish with wondrously little waste a vast amount of the special work of cookery, which is to get as much as possible of the digestion of food done before it reaches the human stomach, and thus to save as much labour as possible to that always hard-working and most important organ. Show the children how the cooking of food in a close stewpan retains all its constituents, while the other processes, as we can tell perfectly well by our sense of smell, are continually parting with atoms of the

substances cooked that never reach our mouths at all. Let them also be taught how much softer the food is made by stewing, how much easier the mastication, how much more perfect the digestion, and how much better the nutrition afforded to the whole body in consequence.

The stockpot.—I have gone a little out of my way to lay particular stress on the advantages in the way of economy both of time, fuel, food, and digestive labour to be gained by intelligent use of the stewpan; and I will conclude by urging, for the very same reasons, the importance of teachers impressing on their scholars the value of the stockpot, with its continual supply of soup. The enormous waste in nutrition caused by simply throwing away the liquid in which our food is boiled is little realised; and the fact, that with the vast number of cheap ingredients by which such liquid may be made into nourishing and palatable soup, with a continual variety of thickening and flavour given to it according to taste, should be constantly drilled into children's minds. If opportunities could be afforded of showing them that in many houses of the upper class the stockpot is kept constantly going, and of tasting its contents, they might be persuaded, when they became housekeepers themselves, to try the system. They would then, perhaps, find that what all Frenchwomen can do most Englishwomen might do as well, with a wonderful advantage both to their persons and their purses, in the way of domestic economy.

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HOW TO TRAIN PUPIL TEACHERS.

CHAPTER I.

THE PUPIL-TEACHER SYSTEM.

1. **Its Origin.**—The Pupil-Teacher System, in its extensive and rapid development, is one of the peculiar features of our National system of elementary education. It is very easy to trace its origin. The mutual system of Bell and Lancaster, useful as it was in indicating how school influence and some amount of elementary instruction could, at little cost, be obtained by the masses—contained an inherent element of weakness. The assistant teachers were unpaid, untrained, unfit children from eleven to thirteen years of age, taken for short periods from the class to act as monitors. After the formation of a committee of the Privy Council, in 1839, to superintend and direct the work of popular education, plans were soon forthcoming for training a class of assistants to whom the objections urged against *monitors* would not apply. Sir James P. K. Shuttleworth, the first departmental secretary, in the course of his inquiries into the working of Continental schools, found, both in Holland and in Switzerland, that promising scholars were often retained as monitors after their course as pupils was completed; that they received instruction from their head teachers in the evening, and, at a fit age, were sent to

Normal Schools to be trained as masters and mistresses. Here were the germs of our pupil-teacher system. It may be well to summarise the regulations made for working this system, as they appeared in the first 'Broadsheet' for apprentices, issued by the Education Department. (I.) The master or mistress had to give proof of competence to conduct the apprentice through a specified course of instruction. (II.) The school had to satisfy H.M. Inspector as being well furnished, well organised, and well disciplined. (III.) Candidates were to be at least thirteen years old, not subject to any bodily infirmity, furnished with certificates both of their own good character and that of their parents, and were required to pass an entrance examination in reading, writing and composition, elementary arithmetic, geography, and grammar, and also to show some aptitude in teaching a class. (IV.) Pupil-teachers were to be the *apprentices* of the head master or mistress, and were bound by formal instrument for a period of five years. (V.) The head teacher undertook 'to the best of his ability' to teach his apprentice 'the business of a schoolmaster; to afford him daily opportunities of observing and practising the art of teaching,' and 'to devote one hour and a half at the least in every morning or afternoon to the further personal instruction' of the pupil-teacher in the subjects laid down in the 'Broadsheet.' (VI.) Stipends rising from 10*l.* to 20*l.* were to be paid by the Department to pupil-teachers fulfilling the necessary conditions, and annual payments were made directly to the head teachers for their instruction. (VII.) Queen's Scholarships, providing two years' additional training at the public expense, were promised to the most efficient pupil-teachers who should successfully complete their apprenticeship.

2. **Growth and Success.**—For a few years the system we have sketched made slow progress. But as soon as it became better known and appreciated, the number of appren-

tices rapidly increased. In 1858 there were 11,390 pupil-teachers in England and Wales; in 1869 they reached 12,842; and the returns for 1878 show that there were then 31,240 pupil-teachers, 28,235 certificated teachers, and 4,100 assistant teachers engaged in elementary schools. The number of children in the schools was over 3,600,000, so that for every adult teacher there are more than 100 children under instruction. A large share of the practical work of instruction must therefore fall to the pupil-teachers. The spirit of searching inquiry into educational principles and methods—which is one of the best signs of the times—has led many to examine closely the past results of this system, and to ask whether they are such as recommend it for use in the future. Remembering that more than thirty years have passed by since the pupil-teacher system was first established, such an inquiry cannot be considered premature.

3. **Criticism.**—We may conveniently divide the critics into two classes: *First*, those who combat the pupil-teacher system as altogether wrong in principle, and who hope to see it entirely abolished. These maintain that, as education is a science, and teaching an art based upon scientific principles, it is absurd to entrust the work of teaching to the immature, undisciplined powers of ill-informed boys and girls. They also point to the many unfavourable remarks which H.M. Inspectors have made from time to time on the usefulness and progress of their pupil-teachers, and would have us draw conclusions altogether unfavourable to the continuance of the system. They compare our educational machinery with that of Germany, where, instead of classes of from twenty-five to forty children placed under a pupil-teacher, we find assistant adult teachers, each in a separate room, with the sole charge of fifty or sixty. The fallacy of these arguments arises from the mistaken notion that there is any similarity between the work usually entrusted to a

pupil-teacher, and that for which an assistant in a Continental school is held solely responsible. Head teachers do not commit the work of educating groups of children to their young and inexperienced pupil-teachers. As we shall show further on, there are many portions of the ordinary routine of school-work which can probably be done as well by a pupil-teacher of fourteen or fifteen, provided he be well instructed and thoroughly supervised, as by an older teacher. Every Inspector knows that it is the personal character and ability of the head teacher, rather than the age of his subordinates, which determine the character of a school. Granting the many advantages of older assistants, yet there is one undeniable advantage in the pupil-teacher system, and that is the extent to which the direct, personal influence of the head teacher can be applied to every part of a school through the agency of the 'apprentices.' The daily supervision and direct assistance, the special instruction in good methods of discipline and teaching, which pupil-teachers receive from head teachers, are surely some compensation for their lack of age and experience.

No one will deny that this system has, for twenty-five years past, furnished the nation with a succession of able masters and mistresses. Who is prepared to state the source from whence an equally good supply may be obtained in the future, if our pupil-teacher system be abolished?

And now we will examine the criticisms of some who point out many shortcomings, although they are favourable to the general principle of the system. This may be fairly described as the position taken by H.M. Inspectors. No other class of men have had equally good opportunities for forming an accurate estimate of the utility of the pupil-teacher system, and it is surely no small argument in its favour that they so unanimously agree in seeking to amend rather than to abolish it. The various charges they have

made in the long series of annual reports may be thus classified. They complain (I.) Of the tender age and general unsuitability of many of the candidates. (II.) Of the difficulties of the pupil-teacher's position—obliged to work in school by day and to devote his evenings to study. (III.) Of the improper use which is too often made of junior pupil-teachers in school. (IV.) Of the poor attainments and lack of culture displayed by the average pupil-teacher, even after four or five years' engagement. (V.) And lastly, of the scanty amount of solid training, either intellectual or professional, which pupil-teachers receive from their head teachers. Heavy as this indictment is, we believe that it is not too severe; but it is rather a charge against the past administration of the system than an argument for its abolition. As the professional prospects of teachers improve there will be no great difficulty in securing suitable candidates, and unwise and ungenerous legislation is largely to blame for much of the apathy displayed by head teachers in this important section of their work.

4. **Its Future.**—We believe, however, that a useful future remains for our pupil-teacher system. (I.) We gratefully acknowledge that recent legislation is in the direction of improvement. The age for candidates is now raised to fourteen years; the syllabus for the examination of candidates for Queen's Scholarships opens out a wider range of study; the number of pupil-teachers is properly limited in proportion to the number of certificated teachers in the school; some portion of school time may be devoted by the pupil-teacher to study, and credit is now given in the Queen's Scholarship examination for skill in class teaching. (II.) The renewed interest of head teachers is another cheering sign. In many parts of the country Teachers Associations have taken upon themselves the work of periodically examining the pupil-teachers; for the latter the useful element of emulation is furnished, while their in-

structors are stimulated to do their part more thoroughly and methodically than before. (III.) The action of certain School Boards in supplementing the regular daily instruction of their pupil-teachers by special central classes under the care of skilled instructors must not be overlooked; we merely mention it here as indicating an anxious desire to remove some of the admitted weaknesses of the pupil-teacher system.

We conclude this chapter by endeavouring to point out the directions in which the Education Department should at once begin to amend this system. (*a*) It should exercise more stringency as regards the qualifications of candidates. (*b*) It should remodel the Syllabus of instruction, so that it may furnish a trustworthy and useful guide to the essential parts of a pupil-teacher's training. (*c*) Now that the supply of head teachers appears to have overtaken the demand; the Department should no longer grant certificates on easy terms to untrained candidates, who will, as part of their work, probably have to train pupil-teachers. (*d*) The important work of training pupil-teachers ought to receive direct encouragement from the State, both by way of special remuneration and special honour to those teachers whose marked success may appear to have earned it. (*e*) The Department should permit some degree of elasticity in the interpretation of its rules, so as to leave more freedom to school managers for providing improved means of training their pupil-teachers. (*f*) The time has now arrived when some further limitation may with advantage be placed on the increase of pupil-teachers. Not more than *two* pupil-teachers should be allowed in any school for each certificated teacher engaged in it.

CHAPTER II.

THE SELECTION AND PRELIMINARY TRAINING OF PUPIL-TEACHERS.

1. **Selection.**—We need say little on the importance of a wise selection of candidates for the pupil-teacher's office. In no profession can the results of personal unfitness be more lamentable, either to the individual or to the work with which he is entrusted. We have, in common with most teachers, experienced the difficulty of always securing really promising candidates, but we maintain that no temporary need of assistance, however pressing, is sufficient excuse for sending up those whom our better judgment pronounces *unfit.* And by what simple rules may we test the fitness of those whom we would place on the threshold of the profession of elementary teacher?

(1.) *Perfect soundness of health.* This ought to be an indispensable condition. The mistake is not unfrequent of choosing a child whose ability and success as a scholar is so far promising, but whose weakly physical development will never stand the severe strain of school-keeping. Such children are pleasant to teach, their success in examinations will be marked, and will earn deserved praise, but as teachers they will achieve little success, even if they do not prematurely break down. We have often thought that the Education Department, besides directing their inspectors to 'oppose the appointment of sickly precocious children as pupil-teachers,' and 'to insist upon good health as an essential qualification,' should also require a more rigid medical

examination, both for candidates and for pupil-teachers at the end of their second year. In far too many instances the certificate, as furnished by the family doctor, only means that its recipient is not suffering from actual disease.

(II.) *Good character.* We would not have too narrow an interpretation put upon this necessary qualification. Honesty, truthfulness, and trustworthiness are, of course implied: we could not recommend a boy to fill the humblest capacity without these; but we demand much more from the candidate for the office of pupil-teacher. The ultimate position he will take in his profession and the amount of useful influence he will exert, will depend far less on mere mental power than on the possession of perseverance and energy, courage in combating difficulties, and the habit of patiently and honestly following the simple round of commonplace duties. The teacher has good opportunities of observing character, and he will have no difficulty in judging whether the disposition and habits of the child are such as give promise of future usefulness and success in the work of teaching.

(III.) *Aptitude for teaching.* Some amount of love of teaching, and aptitude in managing and instructing a small class, should be seen in a candidate before engaging him as a pupil-teacher. A term of probation is very essential for satisfactorily testing this important point. Undoubtedly not a few enter the ranks of our pupil-teachers whose dispositions and tastes positively unfit them for the duties they have to discharge; the work becomes mere drudgery, and they achieve no success in it. If head teachers would always insist on a term of at least six months' probation, they would often save themselves the future inconvenience and discomfort which a useless pupil-teacher necessarily brings, as well as be the means of keeping unsuitable persons out of the profession.

(IV.) *Home influences.* The Education Office has always properly insisted upon a certificate from the managers

stating that the home influences are such as are likely to be helpful to the pupil-teacher in seconding the training and instruction he will receive at school. No one will deny the importance of home influence as affecting the personal character of the pupil-teacher. Unless comfort and peace and regularity reign in the home, unless it afford opportunities for quiet study, unless the sympathy and encouragement which he so much needs be forthcoming—it is difficult to see how the pupil-teacher can satisfactorily and heartily discharge his prescribed duties. Of course the character of the parents is far more important than their mere social position; but, remembering that the stipends of pupil-teachers are barely sufficient to maintain them, and to provide them with clothes and books—still less to assist them during their two years' training in college, it is obvious that the means of the parents must not be overlooked. The improved position of head teachers has recently induced parents of a somewhat higher social grade than that from which many pupil-teachers have hitherto sprung, to offer their children as candidates. Boys and girls who have received a sound and liberal education in a secondary school until their fifteenth or sixteenth year, and who had been engaged only for two or three years as pupil-teachers, will, in the immediate future, often be found in our largest and best town elementary schools.

(v.) *Attainments.* Good reading; a piece of dictation neatly written, well spelt and punctuated; the rules of Practice and Proportion in arithmetic, (Practice and Bills of Parcels for girls); the geography of the British Isles; a knowledge of the noun, verb, and adjective, with their relations in a simple sentence,—such is a brief statement of the acquirements now expected of candidates of fourteen years of age. It would appear from the remarks of many Inspectors in their published reports, that candidates are presented, and sometimes accepted, who barely satisfy even these moderate requirements. It is noteworthy, too, that

this syllabus presents no advance on that originally drawn up, over thirty years ago, for boys and girls of the same age. We have before noticed some of those causes which have in the past tended to diminish the supply of suitable candidates: teachers have been constrained to present, and Inspectors to pass, those who should certainly have been rejected. It is well for head teachers to remember that it is an exceptional case for a backward candidate to turn out a useful and successful pupil-teacher. We fully endorse the remark of Mr. Routledge, in his Report for 1878–9, that 'a little wholesome severity at the outset will prove the greatest kindness in the end, and will prevent many disappointments and failures in after life.'

2. **Probation.**—(I.) *Its necessity.* However promising the candidate, a period of probation should always be insisted on. Success as an occasional monitor, when novelty and the position of authority give some zest to the work, does not afford any trustworthy test of fitness. A term of six months' probation will show the candidate the nature of his future work, will enable him to view it apart from its novelty, to feel some of its attendant trials, and to thoroughly test the liking which many beginners profess for teaching. Such a period will, as a rule, be long enough to confirm, or to correct, any favourable opinion which the head teacher has already formed.

(II.) *Its practicability.* The Department now recognise two stipendiary monitors in the place of a fourth pupil-teacher, or they may fill for two years the place of one pupil-teacher where less than four are required by Article 32 (*c*). They must be at least twelve years old; they must have passed Standard IV. V. or VI., and they are required to pass the next higher standard, and in one or more specific subjects, at the end of their first year. They must be paid a stipend fixed by the managers, they may not assist more than three hours per day in school, and may receive instruc-

tion in the higher classes during the rest of the school hours. This scheme will enable teachers to retain at school promising pupils of thirteen, until they are old enough for engagement as pupil-teachers.

(III.) *How to use probationers.* We cannot too strongly insist that the work befitting a pupil-teacher of some experience—the management of a class—ought never to be thrust upon a probationer. Many a promising candidate is overweighted and speedily discouraged by the burden which, sometimes thoughtlessly, but more often through the insufficiency of the staff, is placed on him. His proper position is, ofttimes at the side, always under the eye, of an experienced teacher. Many minor duties may be assigned to him fairly within his untaught powers, while his presence with a well-worked class will initiate him into the many details of class management. He may have charge of the books and apparatus of the division, and learn proper methods for their orderly distribution and collection; he may acquire care, accuracy, and speed in looking over and correcting the simpler written exercises; he may be entrusted with the registration of class and home-work marks; he may transcribe on the blackboard the examples or exercises for class work; and he may be entrusted with the 'coaching' of three or four backward boys who require extra practice in reading or tables. Soon, a small draft in reading, or tables, or oral spelling, or for blackboard practice in sums, may be entrusted to him. The kindly, watchful eye of the responsible teacher will be always near to aid and encourage him. It is with a view to securing for candidates this useful and pleasant introduction to their work that we strongly urge upon managers the importance of furnishing a sufficient staff irrespective of the probationers. True, the staff will be more expensive; but its increased efficiency will speedily compensate them for the additional outlay. The probationer should be permitted to spend at least two hours of the school day at his own studies. Whether this

time will be more profitably spent with the boys of the advanced class, or in private study, will depend upon the special circumstances of the school and of the candidate. He might also have the advantage of the instruction daily given to the pupil-teachers.

CHAPTER III.

THE TRAINING OF PUPIL-TEACHERS.

1. **Its importance.**—No more important work is entrusted to the head teacher than that of training the pupil-teachers. If these young people are able to render efficient help in the work of elementary education, it can only result from careful and special training. The character of their future work as masters and mistresses depends very much on their preliminary training as pupil-teachers. We do not depreciate the value of the two years' residence in a training college; but it is a well-known fact that the students who excel, either in the class-room, or as teachers in the practising schools, are, as a rule, those who go up from good schools, and from the care of head teachers who have spared neither labour nor pains in their training.

2. **What does the term 'training' imply?**—It will be well here to consider what is comprehended in the term 'training,' as applied to the preparation of pupil-teachers for their immediate work and for their future position.

(1) The head teacher receives his young assistants as '*pupils*,' whose mental culture must be promoted by an extended course of study—suitable, regular, and systematic—under his special guidance.

(2) He receives them as '*apprentices*,' whom he must

train to a thorough knowledge of, and practical skill in, the duties of his profession. Perhaps no better description can be given of this essential part of his responsibility than in the words, already quoted, which stood in the form of indenture originally used in the apprenticeship of pupil teachers: 'The said [head teacher] shall at all times . . . . to the best of his ability, teach the said [pupil-teacher] the *business of a schoolmaster*, and afford him *daily opportunities of observing and practising the art of teaching* in the said school.'

(3) The pupil-teacher is a member of a profession in which high personal character is regarded as the first qualification. There may be wide differences of opinion as to whether religious training should form any portion of the work of the elementary school; but very few will be prepared to deny that it is well for our teachers to be religious men and women. The *moral and religious welfare* of pupil-teachers must therefore be provided for, or their training will lack a most essential element.

(4) No system of training can be regarded as satisfactory which does not take into consideration the *physical well-being* of the pupil-teacher.

This is not the place to quote the many remarks which the varied experiences of Her Majesty's Inspectors have led them to make on the important point of health. The prevalent opinion seems to be that when the candidates are chosen with due regard to health and physique, when their school duties are fairly regulated according to age and experience, when the conditions of space, ventilation, and light are satisfactory, and a fair amount of out-door exercise is secured—there is no reason why pupil-teachers should grow up sickly, or deficient in physical stamina. We believe that managers and head teachers may in many ways consult the health requirements of their assistants; and every scheme of training must be pro-

nounced imperfect which ignores these health considerations.

3. **Education Department requirements.**—These are easily summed up. (*a*) The pupil-teacher must 'receive, without charge, from a certificated teacher of the school, at least five hours' special instruction per week in the subjects in which the pupil-teacher is to be examined, either during his engagement, or for admission to a training college.' (*b*) He must pass, year by year, the examination of H.M. Inspector, including a test of teaching ability. (*c*) He must present satisfactory certificates of diligence, obedience, and attention to school duties from the head teacher, and a certificate of good conduct from the managers.

4. **Acknowledged deficiencies: their origin.**—We have already (see Chap. I.) referred to the acknowledged shortcomings of the pupil-teacher system, and amongst them will be found some which doubtless have their true explanation in insufficient or defective training. An examination of the reports for many years past will show how rarely an Inspector writes in satisfactory terms of the *attainments* of pupil-teachers; while the percentage who are reported as reaching a good mark is invariably small. Intelligent knowledge of the assigned subjects, as distinguished from mere superficial information gained from text-books, seems to be very rare. In the important matter of professional training, Inspectors are agreed that very little practical instruction is given in the art of teaching.

As we have before pointed out, the difficulty of obtaining really good candidates will, in some measure, account for the want of intelligence and culture which have distinguished the average fourth or fifth year pupil-teacher. The incapacity, too, of some head teachers cannot be a source of surprise while the meagre attainments represented by a bare pass in the third division of the first year's examination

papers for certificates will qualify for the work of training pupil-teachers. But in the opinion of those best qualified to speak, head teachers, in far too many instances, bestow little pains on their pupil-teachers, even where they do not absolutely withhold the specified amount of daily instruction. The evil consequences of such neglect, both on the character and future prospects of a pupil-teacher, it would be hard to exaggerate. But blame must not be cast on teachers with unmeasured hand. There are many masters and mistresses who endeavour to discharge to the utmost their responsibilities; who give ungrudgingly much time and careful attention to their pupil-teachers. Their work has been ofttimes beset with difficulties, and no direct honour or remuneration falls to those who are successful in training good teachers. The pupil-teacher is no longer the 'apprentice' of the head teacher, as in the original form of agreement, and 'the moral bond' which formerly joined them seems to be thus weakened. Many teachers now avoid, as far as possible, the responsibility of training pupil-teachers, by employing only assistant teachers. Some take this course because they are anxious to escape a serious addition to their professional duties; others, because they believe the present rapid multiplication of pupil-teachers is fraught with danger to professional interests. The position thus assumed may, or may not, be a wise one; but it is honest. Can we say the same for those who, accepting the responsibility of pupil-teachers, only discharge it with half-hearted zeal? Managers, too, are culpable; the duty of providing a thorough training for the pupil-teachers rests upon them. It is as much the duty of managers to secure the best possible training for their pupil-teachers as it is their bounden duty to provide solid and useful training for their scholars; and one great step towards better things will be achieved when managers become everywhere fully awake to the nature of their responsibility towards their pupil-teachers.

5. **The Syllabus of Instruction for pupil-teachers.** —In giving a brief analysis of the Syllabus, we will first tabulate those portions which are obligatory :—

	ENGLISH SUBJECTS	ARITHMETIC AND MATHEMATICS
1st Year	Good reading. Repetition (with knowledge of meaning) of fifty consecutive lines of poetry. Grammar : the pronoun, adverb, and preposition. Composition : writing a short letter or substance of a passage of simple prose	*Males.*—Vulgar and decimal fractions. *Females.*—Proportion.
2nd Year	Good reading. Repetition : forty lines of prose. The conjunction : analysis of sentences. Composition of full notes of a lesson.	*Males.*—Interest and percentages. Euclid, bk. i. 1–26. *Females.*—Vulgar fractions.
3rd Year	Good reading. Repetition : hundred lines of poetry. Repetition of previous portions of grammar, improved composition, and a knowledge of the Latin prepositions.	*Males.*—Euclid, bk. i. Algebra to simple equations (inclusive). *Females.*—Decimals.
4th Year	Eighty lines of poetry. Some knowledge of the sources and growth of the English language, and original composition.	*Males.*—Euclid, bk. ii. Mensuration of plane surfaces. Algebra to quadratics (inclusive). *Females.*—Interest, and recapitulation of preceding rules.

	GEOGRAPHY AND HISTORY	TEACHING SKILL
1st Year	Europe, with mapping. Succession of English sovereigns, with dates, from Egbert to present time.	To show some skill in instructing and disciplining a class.
2nd Year	The Colonies, with mapping. Outlines of British history to Henry VII.	Increased skill.
3rd Year	Asia and Africa, with mapping. History, from Henry VII. to present time.	Same.
4th Year	America and the Oceans. History: recapitulation.	Ability to manage a division, and to give a collective lesson in class-room to grouped classes.

Drawing and *Music* are expected to be taught where suitable means of instruction exist.

In examining the above Syllabus we cannot but notice the very moderate range of its requirements. Its best defence is found in the fact that so large a proportion of pupil-teachers fail to pass *well*; probably, too, its scope is as extensive as the acquirements of large numbers of certificated teachers. The Department has recently encouraged a wider course of study by giving credit for *one language* and for *one science* in the Queen's Scholarship examination. The restriction is, for the present, a wise one. If a pupil-teacher adds to a solid grounding in the obligatory subjects a useful knowledge of drawing and music, together with Latin grammar or elementary French, and some one branch of science, his attainments will be much in advance of the average pupil-teacher of the past. Probably, as the attainments of pupil-teachers rise, we shall see some of these optional subjects become obligatory, and have a syllabus of

'specific subjects' for pupil-teachers as well as for the higher standards of the boys and girls whom they assist to teach.

6. **Plans for the instruction of pupil-teachers.**—(I.) The Education Department insists upon the strict observance of the principle that the five hours' special instruction shall be given by a certificated teacher of the school to which the pupil-teacher belongs. This is a departure from their old standpoint, that *head teachers alone* should give this instruction, although, practically, the head teacher is still responsible. The difficulty of directing simultaneously the instruction of three or four pupil-teachers, possibly all of different years, is often insisted on; but, on the other hand, this plan secures each pupil-teacher the constant supervision and assistance of the person who takes, or should take, the greatest interest in his professional welfare and success.

Where the schools are large, the plan of grouping the pupil-teachers in classes, each under the charge of a certificated teacher, has much to recommend it: the training will be more thorough because the teacher's energies are undivided.

(II.) *The Centre System.* An application of this latter plan (not to the three or four departments of a school, but to a district) constitutes the so-called 'centre system,' sometimes advocated. Many things may be said in its favour: the weakest feature would be the loss of the individual responsibility of each head teacher for the progress of his or her own pupil-teachers.

(III.) *Supplementary instruction of pupil-teachers.* Some years ago the Liverpool School Board established a 'Pupil-Teachers' College.' At first females only attended, but now teachers of both sexes are received. Its purpose is to *supplement the work of the head teachers*, and to enable their pupil-teachers, 'grouped in classes, to take a broad and

comprehensive view of the subjects, in order that they may pass the examinations with greater credit, and teach the several subjects with increased power.' Females of the first and second years attend the college one afternoon each week; the other pupil-teachers attend one or two evenings each week from six to eight o'clock, and for two hours on Saturday morning. A staff of skilled lecturers is provided, and the subjects taught comprise Arithmetic, Mathematics, English Grammar, History, Latin, French, Music, Animal Physiology, Domestic Economy, Physics, &c.

Liverpool pupil-teachers thus have the advantage of preparation by their responsible teachers, the special skill of their college lecturers, and that valuable stimulus which the method of class working supplies.

(IV.) *Examination schemes.* Such a well-planned scheme as that above described is only possible in the great centres of population. But in no district are the pupil-teachers so scattered that they may not be periodically called together for examination in some pre-arranged portion of the year's work. The useful examination schemes set on foot by several teachers' associations are deserving of success. They afford useful experience and wholesome stimulus both to teachers and taught; they encourage regular and systematic preparation, and they afford welcome evidence that head teachers are bestowing increased and careful attention on the work of training pupil-teachers.

CHAPTER IV.

THE INSTRUCTION OF PUPIL-TEACHERS.

In this chapter we shall consider the intellectual training of pupil-teachers, reserving for succeeding chapters their moral and religious training, and their special preparation for the work of teaching. Practically these are inseparable; at every point in the work of intellectual training the special use to which pupil-teachers will apply their acquirements must be distinctly kept in view; and the important work of the formation of character depends on the motives which are appealed to, the habits which are fostered, and the spirit which pervades the whole school, as well as upon formal instruction in the principles of morality and religion. It will be assumed throughout this and the succeeding chapters that the head teacher is unaided by any of the special schemes described in Chapter III. This is the ordinary position of things except in a few localities, and will probably remain so for some time to come. We shall endeavour neither to underrate nor yet to magnify difficulties, and shall try to suggest such plans as have stood the test of experience and been found useful.

1. **Time and place of instruction.**—The Education Department requires five hours' instruction per week (of which not more than two hours may be given in one day), and the whole of this time must be devoted to the work of the Syllabus, or of such subjects as appear in the scholarship examination. Few teachers who take a warm interest in

their pupil-teachers are willing to restrict themselves to this specified amount; many give an hour and a half per day, others an additional hour or so on Saturday morning. The most suitable *time* is before the ordinary duties of the day begin, from 6.30 to 7.45 or 8 A.M. in the summer months, and from 7.30 to 8.45 in winter. Special difficulties will occasionally render these plans impracticable, and it will be then better to meet the pupil-teachers on three evenings in the week for two hours' study—*not* immediately after school when both head teacher and pupils are unfit for work—but when they have been refreshed by tea and a short period of rest. If this plan be followed, the work assigned for preparation should be so arranged that the heavier tasks may fall on the remaining evenings. Many teachers prefer the hour from 12.10 to 1.10, and the plan has this advantage—the work of the day is compressed into a smaller number of hours, but it must necessarily be accompanied with the drawback of either a cold, comfortless meal in the school-room, or a hurried visit home. The considerations of health and comfort, of economy of time, and the necessity of both teacher and pupils bringing to this important duty their freshest energies, all point to the earlier hours of the morning as the more suitable. The proper place for instruction will be a class-room, or the head teacher's room in the school-buildings. Here books and appliances are at hand, and arrangements can be made in winter for the room to be comfortably warmed.

The *regular* and *punctual* attendance of the head teacher is most essential. No head teacher can honestly believe that the presence of the pupil-teachers (even presuming they have occupation assigned them) will, in his absence, satisfactorily meet the requirements of the case: he is bound to give *at least* five hours' *instruction* per week. Great harm both to the prospects and the characters of the pupil-teachers must ensue when any laxity in the interpretation of plainly expressed duties is permitted to prevail. The

regular and punctual attendance of the pupils will be, as a rule, readily secured when the head teacher sets a good example. In some schools each pupil-teacher keeps a register or diary of his attendance, the special work set for preparation, and the reports of the teacher on its execution. A specimen of the form suitable for such a diary will be found on page 32.

2. **Methods of instruction.** — The teacher's aim should be to use such methods as seem best adapted to impart sound instruction, to cultivate general intelligence, and to prepare his pupils for their after-work as teachers. This threefold object seems most likely to be accomplished when the teacher succeeds in combining in fit proportion the *use of good* text-books, *direct oral instruction*, frequent *written exercises*, and *periodical test examinations*. We purpose examining the value and place of each of these means.

(1.) *Text-books.* The Department, in its directions to managers, draws their attention to 'the importance of taking care that the principal teacher, and each pupil-teacher, be furnished with a good text-book for private study on each of the subjects of examination.'

The best plan is for each pupil-teacher to possess a set of the necessary text-books. Some managers indeed supply them free of cost, but it is better that the pupil-teachers themselves should pay some share. The head teacher should take care that the books selected are *good*, likely to be permanently useful, and also likely to encourage genuine study rather than superficial 'cram.' Those manuals which attempt to collect within the compass of a hundred or so of pages the materials of a year's study had better be avoided: 'summaries' should only be encouraged when they are the results of the pupil-teacher's own painstaking analysis.

As regards the *use of text-books*, much care must be exercised. When the 'getting up' of text-books, and a

bare, formal examination constitute the so-called 'instruction' given to the pupil-teacher; when, in fact, 'the text-book takes the place of the teacher,' no sound progress, and very little worth calling mental cultivation, can follow. Such a course of preparation will encourage mere verbal memory, to the exclusion of that thoughtful examination of facts and their mutual dependence, which alone can make the acquisition of knowledge a means of mental culture. The special work of the teacher, therefore, in connection with the use of text-books, is to see that the *intelligence* of his pupils is cultivated, as well as their stock of information increased. Direct oral instruction must supplement the use of the text-book; and searching *vivâ voce* examination upon the meaning and spirit of the passage will only fulfil its highest purpose when the teacher is able to assist, by definition, or example, or illustration, the deficient appreciation of the pupil.

It is unwise to put several text-books on the same subject into the hands of a pupil-teacher: of course this remark does not refer to the occasional use of books of reference for fuller information, or a clearer exposition of some difficult point. But, as every student knows, there is direct gain in becoming familiar with the very appearance of a book, both as regards memory and after-use. A few pages of blank paper may be fastened at the end of the text-book for such MS. notes as the teacher may think desirable.

(II.) *Direct oral instruction.* Besides the useful instruction which will accompany all well-conducted oral examinations, an occasional oral lesson or lecture will be very beneficial. (*a*) There are periods of special difficulty with the young student, when ten or fifteen minutes' direct oral teaching may save him hours of fruitless labour; such help is especially necessary in the use of mathematical text-books. (*b*) In some subjects, such as history and geography, pupils may very well be left to work up from their text-book the facts of a given subject, but the relative value of those facts, their mutual dependence, and their more re-

mote consequences, will be best taught in a special oral lesson. It must not be forgotten that any time thus spent will be amply repaid by the increased zeal and intelligence which the pupils will bring to the preparation of their tasks.

(III.) *Written exercises.* These should be of two kinds. (*a*) Written examinations on prepared work. (*b*) Questions set to be answered at home in writing. Of course these questions must not be of such a character that the pupil may at once transfer the answer from the text-book to the pages of his exercise-book; they should be questions involving the application of facts rather than mere reproduction. For example, the pupil will find in his text-book the materials for writing an imaginary account of a journey down the Danube, or for a comparison, say, of the physical features of the Spanish and Italian peninsulas; but he will have also to select and combine these materials with some intelligence and judgment. Such questions will often suggest themselves in the course of teaching, and should be set as a corrective to the mechanical form in which young pupils are too apt to answer examination questions on prepared work.

(IV.) *Periodical test examinations.* The object of these test examinations is twofold. (*a*) They enable the teacher to gauge the progress of the pupil; they should therefore occur at regular intervals of time. We shall presently propose that the work of the Syllabus be divided into monthly portions; a monthly test examination of two or three hours will then be sufficient. (*b*) They are useful in accustoming the pupil to work examination papers with due regard to the number of answers required and the amount of time permitted—a point in which many young examinees are weak. If this latter purpose is to be fulfilled, the conditions of the ordinary test examination must be as strict as in that of H. M. Inspector.

3. **Difficulties.**—Here we pause to consider a common

difficulty—that of the teacher who is charged with the instruction of three or four pupil-teachers in different years of their engagement. How are satisfactory plans to be arranged under such circumstances? We have, in common with most teachers, felt this difficulty, and, like many more, we have found that if it be fairly grappled with it is not insuperable. No doubt, with a class of three or four pupils of the same standing, the work of instruction would be much simplified, and its results in many ways more satisfactory. But we are persuaded that much may be done to reduce the acknowledged difficulty to tolerably small dimensions. Some of our suggestions will not commend themselves to those head teachers who carefully restrict the hours for instruction to one hour per day for five days per week. (*a*) The senior pupil-teachers may attend a little earlier, or receive an hour's extra instruction per week, so that they may have the benefit of special help in those subjects which happen to need it. (*b*) A careful arrangement of the *Time Tables* for daily work will enable the teacher to provide for a fair alternation of written exercises and oral teaching, so as to meet the requirements of all. (*c*) Even under extreme circumstances, when each pupil-teacher is in a different year, some amount of 'grouping' is usually possible. The well-advanced pupil of one year may sometimes with advantage take much of the work of the next pupil-teacher; and the seniors may usefully review part of the work of the juniors. (*d*) Much time usually spent in correcting written work may be secured for direct teaching, if the head teacher will reserve for after perusal exercises requiring careful supervision.

4. **Plans.**—It may be thought that no remarks urging the necessity for carefully considered plans of work should be required; but, unfortunately, it is not so. With some head teachers the subject taught on any special day, and the

assigned tasks to be prepared, are matters of whim or mere chance. The Syllabus appoints a certain amount of work to be achieved; each pupil-teacher's requirements must be considered; every subject ought to have that amount of attention which its relative importance or difficulty demands;—surely these facts alone show the necessity for methodical work. We will give a few practical hints which we believe will be useful.

(I.) Subdivide the work of the Syllabus so that it may be completed in eight or nine monthly portions. This will tend to correct the common mistake of proceeding too leisurely in the earlier part of the school year; and the last three months will be reserved for the important work of recapitulation, and for frequent test examinations. Our space will not permit us to give an extended scheme for the whole four years of apprenticeship; but we give as a specimen, a detailed scheme for a portion of the second year's work, keeping with sufficient accuracy to the work as laid down in the Syllabus.

ENGLISH GRAMMAR. *1st month.*—The simple sentence: subject, predicate, object, extensions of predicate; exercises in analysis of a simple sentence.

2nd month.—Noun, adjective, and adverbial phrases; continued exercises in analysis. The conjunction: kinds of conjunctions; how to distinguish them from adverbs, relative pronouns, and prepositions; correlatives; compound conjunctions.

3rd month.—Inflections of noun to be reviewed; complex sentences; principal and subordinate sentences; noun, adjective, and adverbial sentences; exercises.

4th month.—The adjective reviewed; exercises in analysis and parsing.

5th month.—The pronoun reviewed; compound sentences; analysis and parsing.

6th month.—The verb reviewed; conjugations, voice, mood; review analysis of a simple sentence.

7th month.—The verb; tense; anomalous verbs; auxiliary verbs.

8th month.—The adverb and preposition; exercises in analysis of complex and compound sentences.

9th month.—The conjunction reviewed.

GEOGRAPHY AND MAPPING. *1st month.*—Europe; boundaries, dimensions, outline, capes, and openings; surface, the Great Plain, mountain systems; outline map of Europe to be practised for memory drawing.

2nd month.—Line of watershed; rivers grouped according to 'drainage basins'; climate, its peculiarities and their causes; map of Europe, outline and chief physical features from memory.

3rd month.—The countries; France.

4th month.—Spanish and Italian Peninsulas, with memory maps.

5th month.—Turkey and Greece, with Mediterranean and Black Seas.

6th month.—Holland, Belgium, and Denmark; the Rhine.

7th month.—Germany and Switzerland; the Alpine system.

8th month.—Austria and Russia; the Danube.

9th month.—Norway and Sweden; the Baltic and White Seas. Memory maps to be a portion of each week's work.

(II.) Arrange a table of subjects in the order in which the pupil-teachers are to prepare them day by day. The important points to attend to are—(i) Variety in each day's work; (ii) A due proportion of time to each subject. We strongly urge the plan of simultaneous work at all the subjects throughout the year, in preference to reserving the so-called easier subjects to the months immediately preceding the examination. We add a specimen table in actual use, merely stating that the pupil-teachers attend for extra instruction on Saturday, and that some portion of the divinity, and the instruction in drawing, are not given by their responsible teacher. The pupil-teachers also have the benefit of about an hour and a half daily, in school hours, for private study.

MONDAY	Latin grammar and exercises; geography (sketch map to be shown); arithmetic.
TUESDAY	French (exercises); English history; English grammar (text-book).
WEDNESDAY	Euclid; exercises in English grammar, and analysis; practice in mapping.
THURSDAY	Algebra; geography (history on alternate weeks); notes of lessons.
FRIDAY	Latin; school management; arithmetic (Seniors' 'Mathematics').
SATURDAY	Divinity; French; English composition (repetition every third week); music, or a paper of questions to be answered in writing.

(III.) The necessary counterpart of this 'Table for preparation' is the plan which, in its main features, regulates the disposal of the time spent in daily instruction, and this we also give.

MONDAY	Compositions read and discussed, or repetition heard; divinity examined, orally or by written questions.
TUESDAY	Thirty minutes' paper work in geography and Latin grammar; arithmetic and sketch maps examined; occasionally, oral examination or lesson in geography.
WEDNESDAY	Juniors examined orally in English grammar while seniors answer history questions in writing, or *vice versâ*; French exercises read *aloud*, and corrected.
THURSDAY	Juniors' Euclid examined orally, while seniors draw memory map; seniors—Euclid, while juniors draw maps; grammar exercises examined.
FRIDAY	Algebra and notes of lessons of each pupil examined in turn; oral examination of prepared work, or special lesson.
SATURDAY	School management; discussion of answers to questions and of prepared notes of lessons; Latin examined; reading practice on alternate weeks.

As will be seen by comparing the above tables, some of the written exercises are necessarily reserved for after examination.

(IV.) Let each pupil-teacher keep a diary, containing a record of the work set for preparation, and the written remarks of the teacher upon it. It may also contain a record of the attendance at daily instruction, and the results of the head teacher's periodical examinations. Such a diary is useful as an *incentive* to the pupil-teacher; it will *furnish evidence of the regularity and zeal* both of teacher and pupils; and it forms *a useful record* of work accomplished. We give a form suitable for the purpose; it may be ruled up as required on the blank pages of an ordinary exercise book.

Date	Instruction		Preparation	Teacher's remarks
	Begun	Ended		
Sept. 15	7.35	8.45	Todhunter's Algebra, xxi. 5–10. Daniel's History—William II. and Henry I. Notes of lesson for Standard III. — 'The English Channel.'	Neatly and correctly solved. Carefully prepared, excepting dates. F. good.

5. **Teaching hints.**—We will now offer a few practical suggestions on teaching the various subjects which form the curriculum of a pupil-teacher. We shall endeavour to show in what points the teaching is most deficient, basing our observations on the reports of H. M. Inspectors. We shall also name those text-books which appear to be most useful for the special purposes of pupil-teachers, although we cannot pretend to name every trustworthy book now in use. It will be our duty to point out to the head teacher the necessity of pursuing some subjects independently of the

arrangements of the Syllabus, if he would pay due regard to the progress of his pupils in mental culture.

(I.) **Reading and repetition.**—We fear the art of reading receives little direct attention in the instruction of pupil-teachers. It is an undoubted fact that the reading aloud of large numbers who enter the training colleges is very defective; it is no uncommon thing to find students who state that, as pupil-teachers, no opportunities for practice were afforded them. Yet the necessary outlay of time spent in reading practice would be amply returned to the head teacher in the increased practical skill which the pupil-teachers would bring to the work of teaching reading. Neither need the amount of time devoted to practice in reading be great; thirty or forty minutes every other week, *regularly set apart* for the purpose, will be enough, *provided it be well used.* (*a*) Teach systematically, and 'one thing at a time.' Begin by endeavouring to correct any prevalent form of bad pronunciation; here special exercises in pronunciation will be useful. (*b*) Try to secure the habit of a deliberate, measured style of reading, slow rather than fast, undue rapidity being the parent of many common faults of delivery. (*c*) Endeavour next to secure distinct articulation; the habit of measured reading will make this possible. Short passages read again and again, with strict attention to distinct utterance of each syllable, and especially of the initial and final consonants, will be useful. (*d*) Cultivate reading with expression by the careful practice of well-chosen passages of prose and poetry. Notice should be given of the passage chosen some days before the reading lesson, and the pupil-teachers should be expected to make themselves tolerably familiar with it—in fact, to prepare it with a special view to good reading. One passage well practised—with due attention to proper pitch and rate of utterance, to just emphasis, to suitable pauses, and appro-

priate modulation—will do more good than much desultory practice.

The amount of 'repetition' expected seems ridiculously small, when compared with the 200 or 300 lines demanded for a pass in literature for a child in Standards V. or VI. But the small portion assigned is deserving of more attention than is sometimes given to it; it furnishes an opportunity for special practice in elocution, and also the materials for useful mental culture. It will be well for the selected passage to be thoroughly studied *in class*, before it is committed to memory. After the difficulties of phraseology and of construction have been mastered, and something of the meaning and spirit of the whole passage have been imparted, then let it be read in class repeatedly, and finally be produced as an exercise in recitation. If head teachers would thus aim at special excellence in this exercise, they must not reserve it, as an unimportant part of the Syllabus, to the weeks immediately preceding the Inspector's visit. The Education Department would add increased value to this exercise, by choosing passages of not less than 100 lines for recitation, and by setting in the grammar paper a few questions upon the passage. The work of preparation would be much better done if the Department would also permit the same passage to serve for all the pupil-teachers in a school, exacting, of course, a higher degree of proficiency from the seniors.

(II.) **English grammar and composition.**—These are subjects in which, if we accept the unanimous opinions of H. M. Inspectors, pupil-teachers generally are weak. Almost any report taken at haphazard from a blue book will confirm this statement. As regards English grammar, perhaps no subject is more likely to suffer from the head teacher's lack of general culture. Mr. Fearon, in his work on school inspection, says: 'English grammar is unfortunately taught in our elementary schools by teachers who for

the most part are unacquainted with the grammar of any other language. The consequence of this is that they have no power of steadying their thoughts and testing their conclusions in English grammar by comparison of them with their thoughts and conclusions in the grammar of any other language living or dead. The Inspector, even if he does not know something of Old English or German, is saved from many a mistake into which the teacher falls, by his knowledge of Latin, and it is impossible to overrate the importance of even a little knowledge of Latin for the purposes of an elementary school teacher.' Admitting the truth of this, we at the same time maintain that the Syllabus is both vague in its statements of what is required, and faulty in its arrangement. Analysis of sentences, which has hitherto been reserved for the third-year teacher, ought to be begun in the first year. Considering what is expected from children in Standards V. and VI., the pupil-teacher may reasonably be expected to know all the parts of speech with their inflections, and to parse and analyse easy sentences. For the second year, a fuller knowledge of analysis, together with an acquaintance with the rules of syntax, would form a suitable course. In the third year, instead of the meagre and unsatisfactory reference to etymology contained in the Syllabus, which merely requires the pupil to know 'the meaning in English of the Latin prepositions,' a systematic study of word-formation should be commenced. This, with a thorough recapitulation of 'Inflection,' would afford a year's good work. The Syllabus for fourth-year teachers states that they should 'know something of the sources and growth of the English language:' if an exact and detailed account were given of what should be prepared, more attention would soon be bestowed upon this useful subject. In any future revision of the Syllabus we hope to see some specific portion of *Latin grammar* assigned for each year of engagement. On the work of preparing the pupil-teacher we can only give here a few general hints.

(*a*) Be specially careful what text-book you choose. It is not too much to assert that many grammars afford little insight into the difficulties of the language. Our difficult constructions are only the remains of old forms, once simple and intelligible enough, and a preference should be given to those grammarians whose knowledge of Old English renders them competent guides. The works of Dr. Morris, of Mr. Mason, and of Professor Bain, may be named. Morris's 'Primer of English Grammar' may with advantage be made the basis for the preparation of pupil-teachers in their first and second year; and the same author's 'Elementary Lessons in Historical English Grammar,' or Mason's English Grammar, for the work of the seniors. Grammatical analysis is treated with sufficient fulness in nearly all the good grammars, but it is nowhere expounded more simply and completely than in Dr. Morell's books. (*b*) The text-book preparation should always be followed by careful oral examination, and the written exercises in parsing and analysis will be more useful if they directly illustrate the passages prepared. A book of 'English Grammar Exercises' has been compiled to accompany Morris's 'Primer,' and Morell's 'Graduated Exercises' will afford abundant systematic work in parsing, word-building, and analysis.

The Rev. T. W. Sharpe, H. M. Inspector of Training Colleges for Males, in his report (1876–7) on the examination for Queen's Scholarships, says: 'The most serious deficiency is in English composition, the want of power to disentangle their ideas and to express them with brevity; diffuse language and obscurity of thought *are the rule.*' To this important testimony we might add that of many other Inspectors to the effect that the composition of senior pupil-teachers is very defective. 'Stops thrown about carelessly, commas used for full stops, commas succeeded by capitals, subjects lacking predicates, unwieldy and incomplete sentences, punctuation omitted altogether, or evidently misunderstood,'—we might suppose this de-

scription to refer to the efforts of a Fourth Standard boy rather than the examination work of third-year pupil-teachers in an important manufacturing district. How can such facts be accounted for except on the supposition that the pupil-teachers had received no direct instruction in composition, and had rarely been called upon to commit their thoughts, or even their information, to paper? Our first piece of advice then shall be this: (*a*) Let written exercises be worked on paper in every subject throughout the year, and pay the same regard to slovenly or faulty composition as you do to bad spelling or misstated facts.

(*b*) Give special attention to composition. Remember that any deficiency here will affect nearly all the other work when the time for examination arrives.

(*c*) The simplest exercises are those in which the pupil can give his whole attention to composition, the teacher furnishing him with materials by reading some simple narrative or descriptive piece. As he gains skill he should be exercised in original composition on such easy topics as come within the scope of his experience or means of information. A weekly theme will be enough, and its examination had better be made a *class exercise* in which all join in kindly criticism. This is a subject in which the smallness of the number of pupils will be an advantage; for one or two short compositions, fully discussed and corrected, will occupy a half-hour or more. Begin with a brief examination of the way in which the subject is handled, as regards choice and arrangement of facts and illustrations, and the conclusions arrived at. Then go on to discuss the composition. Grammatical blunders, bad punctuation, and misuse of capitals should first be pointed out; next, the choice of words may be criticised, both as regards their simplicity and the accuracy with which they convey the writer's meaning. Then give special attention to brevity:—take each long and involved sentence and show how simpler arrangement and excision of all redundancies will impart

clearness and strength. Pupil-teachers will speedily learn to write with care, and with reasonable approach to accuracy and precision, if their exercises are occasionally handled in the way we have indicated.

(*d*) Some degree of flexibility of style may be imparted by judiciously varying the selection of subjects. Descriptions of scenery or places of interest recently visited, letters to be written in familiar and pleasant style, narrative sketches of events either actual or imaginary; expositions of some assigned text, e.g. 'Manners make the man'—these exercises will afford variety and secure sustained interest.

(*e*) *Books on composition.* These need not be put into the hands of the pupils, but there are several books which will afford useful assistance to the teacher. Amongst these we would recommend Abbott's 'How to Write Clearly,' and Professor Nichol's primer on 'English Composition.'

(*f*) Paraphrasing is an exercise which will only be of service to the pupils who have attained some proficiency in the simpler forms of composition. It is not an exercise for the learner, and it is not required in the annual examinations of pupil-teachers, although it usually appears in the examination for Queen's Scholarships. It is a valuable exercise for an advanced pupil-teacher, because it demands a close study of the author's meaning, trains to habits of care and discrimination in the use of words, and cultivates variety in modes of expression. The only exercises attempted should be such as require passages with difficult phraseology or involved construction to be turned into simple plain English. These must be carefully criticised and corrected; rules will be of little service, but regular practice will in time bring facility.

(III.) **English History.**—The useful but wearisome tables of succession and dates which are set as the history subject for the first year are not likely to inspire the young

teacher with much interest in the subject. It would be better for first-year pupil-teachers to study some section of history with their seniors, in addition to the work specially assigned. According to the reports of the examiners, a pupil-teacher's knowledge of history rarely advances beyond a more or less accurate acquaintance with the contents of some small manual, studied with zeal, but with small exercise of intelligence. Four years' preparation, if it be conducted with any care or skill, should produce better results. The history lesson is one of those on which the skilled teacher will especially rely, as affording him abundant opportunities of training not only the memory, but the judgment, the reasoning powers, the imagination, and the moral sense of his pupils. We would urge every head teacher to read the manual entitled 'How to Teach History,' published by the National Society, for a full exposition of the important services which history may afford in the work of mental culture. Our hints must of necessity be very brief. 1. Your examinatory questions, both oral and written, will to a great extent determine the degree of intelligence which your pupils will bring to their text-book preparation. Endeavour to set your pupils to find out the connection of facts, to trace effect back to cause, to compare things past with things present, and do not set questions which encourage a parrot-like reproduction of the pages of the text-book. 2. Do not permit your pupils to follow invariably the order and method of the text-book. Too often the way in which events are classified under headings is artificial and misleading. It is doubtless convenient to begin the history of a period by learning the succession of sovereigns, something of their personal history, and the events with which they were connected. But when this is done, take the one or two important events which mark the period, and have them studied systematically and thoroughly. 3. See that you give due prominence to the 'history of the people.' The pupil-teacher will want much assistance here, for the amount of

information usually afforded on this point in school text-books bears no relation to its importance and utility. Fortunately the industry of modern historians has made available abundant stores of information, and the publication of such books as Green's 'Short History of the English People' has placed ready to the teacher's hand the materials he requires. 4. If the pupil-teacher is to succeed as a teacher of history, no possible means must be overlooked of giving life and reality to his impressions of past events. Show him pictures of old armour, dress, or implements; encourage him to visit museums containing any historical relics; refer him to the 'word-pictures' painted by Chaucer, Shakespeare, Scott, and Macaulay; read with him the stirring and descriptive accounts of the old chroniclers, or the admirable collection of 'Readings from English History,' recently selected and edited by Mr. Green. 5. Pause occasionally to study some important biography. There is no readier means of gaining interest in an important event than by presenting it in its personal aspect, and no surer way of unravelling the tangled threads of a period than by learning how they meet in the life of some individual. 6. Much industrious recapitulation is required in mastering the mere outlines of English history. Encourage your pupils to analyse and tabulate their information for themselves; have sketch-maps and plans drawn illustrating the more important campaigns and battles; encourage them to refer to the larger histories for full information on important points, and have frequent 'notes of lessons' drawn up on selected points of interest. 7. We recommend Daniel's 'Outlines of English History' as a first book for pupil-teachers. Either of the well-known manuals by Milner, Curtis, or Ross will be a useful text-book for the seniors, and Collier's 'Advanced Class Book' should be used both for the valuable information it affords about the people, their manners and customs, &c., as well as for its graphic descriptions of important events. Every pupil-teacher should also have access to Mr. Green's

history above referred to, and to some of the larger standard works on English history.

(IV.) **Geography and Mapping.**—(1) The Syllabus appears to us to directly encourage that unintelligent knowledge of facts which the examiners so frequently condemn. Side by side with it there should be a well-arranged course for instruction in 'Physical Geography,' embracing at least as much information as would be comprehended in a thorough knowledge of the contents of the schedule for Standards IV. V. and VI. The pupil would then be in possession of those broad principles which alone can enable him to see the importance and mutual connection of geographical facts. (2) We shall be able to discuss only four practical points connected with the preparation of pupil-teachers in this subject.

(*A*) *Encourage an intelligent study of Geography.*

(*a*) Provide for a regular course of reading in some sound text-book of physical geography. You may commence with Geikie's 'Primer of Physical Geography.' In this little book 'a shower of rain, the flow of a brook, the muddy water of a river, the shape of a cliff, the outlines of a mountain,' are made the commonplace but sufficient means to illustrate all-important principles. The pupil might then with advantage read some larger manual, such as the same author's 'Elementary Lessons in Physical Geography.'

(*b*) Encourage your pupil-teachers to use their eyes and their reason in mastering the geographical facts of their own neighbourhood, by often asking for home illustrations in place of those furnished by the text-book. They will thus learn that the observing eye can study at home as well as abroad those movements and changes which make up the sum of natural phenomena. The vast utility of this to their work as teachers need not be dwelt on here.

(*c*) In your oral teaching, and your examinations on the

work of the Syllabus, do not be content with mere facts, however fully or accurately they may be produced; test how far your pupil can account for them, and explain their relative importance.

(*d*) In studying any country, have the physical features mastered, and make them serve as a key to explain the political and industrial features.

(*e*) Encourage an intelligent use of memory by making your pupil use constantly the methods of comparison and generalisation. A careful contrast, for example, of the physical features of Africa and South America (even if not followed by an examination into the causes which have produced differences so remarkable), would serve to impress both sets of facts indelibly in the memory.

(*B*) *A thorough and accurate knowledge of facts must be secured.* The means we have suggested for ensuring intelligent study will, if pursued, assist the attainment of a full and accurate knowledge of facts. But there are certain elements of geographical knowledge (e.g. that of position on the earth's surface) which require special attention. (*a*) Let your pupil-teacher learn such details as longitude and latitude of places, lists of capes, &c. *directly from the map*, instead of the pages of a text-book. (*b*) Rely much upon pen-and-ink map-drawing for securing an accurate knowledge of many facts: we never permit our pupil-teachers to prepare for us a chapter in the text-book, without also bringing for inspection a sketch-map with every detail inserted. (*c*) Encourage a high standard of skill in map-drawing. (*d*) In recapitulation, do not have the old ground retraversed in the same beaten track. If, for example, England as a whole has been worked up in the text book, study in detail the geography of its river basins, then the distribution of its industries, then its means of external trade. Many of the same facts will come over and over again, but each time with new importance. (*e*) Use every possible means of getting your pupil-teachers to *realise facts*, or they will never

teach geography well. Books of travel, works on natural history, pictures, country or seaside visits—all these in a greater or less degree will aid in giving accurate and definite impressions.

(*C*) *Mapping.* The relation of mapping to the acquisition of an accurate knowledge of facts has already been pointed out. We here wish to say a few words on drawing maps from memory. If a high degree of accuracy is to be attained, the subject must be steadily pursued throughout the pupil-teacher's engagement. To be able to draw from memory, quickly and correctly, such an outline as that of Great Britain, will demand much persistent practice; but the skill when attained is well worth the trouble involved. The outline mastered, let the pupil learn to insert from memory the mountain and river systems. Faunthorpe's 'Elementary Physical Atlas' will be found very useful. As your pupils advance, teach them how to construct projections for the chief maps, and have projections scratched deeply on the surface of a slate, so that the pupil may, by repeated practice, gain the skill requisite to lay a correct outline upon the projection. All necessary technical information is afforded in Faunthorpe's 'Atlas.' Frequently call upon your pupil-teachers to draw blackboard memory maps, and so prepare them for this most useful feature in the teaching of geography.

(*D*) *Text-books.* The books of W. Hughes, Richardson's 'Manual of Geography,' and Lawson's books, for general work, and Hewitt's 'Colonies,' are all excellent. The two little volumes entitled 'Near Home' and 'Far Off' are excellent for pleasant descriptions of other lands and peoples; and the physical geographies of Geikie, Page, and Skertchley will be found very useful.

(v.) **Arithmetic.**—The reports of H. M. Inspectors indicate generally that pupil-teachers are 'successful in working sums in strict accordance with rules, that questions involv-

ing thought are generally avoided, and that solutions fully exhibiting processes of thought are rarely given.' These criticisms seem to us to point out the means by which head teachers must seek to obtain for their pupils a higher standard of proficiency. (1) Endeavour to make your pupils masters of the principles of arithmetic; nothing short of this will make them good arithmeticians, or fit them to teach the subject satisfactorily. A course of progressive oral lessons on the principles which underlie the operations of the first four rules will be a useful piece of mental discipline, and will prepare them, as nothing else can, to teach them to children. Such a course should be followed by instruction in some of the more useful properties of numbers, and then by a complete course of demonstrations on the principles of fractions, ratios, proportions, &c. The home work exercises and test examinations should always contain some questions on these principles. Books will be of little use to the pupil, but the teacher will find all the assistance he needs in De Morgan's 'Arithmetic,' Cornwall and Fitch's 'Science of Arithmetic,' and Piper's 'Advanced Arithmetic.' Mr. Girdlestone's excellent text-book will also be found very useful. (2) Do not be satisfied with correct results. This is a point of great importance. Always have the working completely exhibited, and insist upon an orderly arrangement of the processes, so that every solution may be self-explanatory. You cannot possibly submit your pupils to a more useful mental discipline than that involved in showing clearly the method pursued in each worked example. (3) Give large numbers of problems, i.e. questions which require to be analysed, and which cannot be at once solved by the mechanical intervention of a rule. A paper with four or five such questions, drawn from sources other than the text-book in the hands of the pupil, should regularly alternate with work taken in order from the text-book. (4) Teach carefully all useful abbreviated methods of working, and train your pupil to examine each

question before solving it, with a view to discover the quickest and neatest solution. (5) As a summary then of important points, we repeat: (*a*) Give clear black-board explanations of the principles underlying each rule, and let the pupil-teachers preserve these demonstrations in their note-books for after use. (*b*) Carefully revise every solution worked. (*c*) Give frequent papers of miscellaneous examples, some involving long and complex working, to cultivate accuracy in the manipulation of figures, and some questions requiring careful analysis. (*d*) Cultivate rapid work by occasional papers of test examples to be worked in a limited time. Amongst the text-books which contain abundance of good examples, we may name the well-known books of Colenso and Barnard Smith, and the more recent manual written by Mr. Hamblin Smith.

(VI.) **Mensuration.**—This subject will be found treated with sufficient fulness for pupil-teachers in Lewis's 'Elementary Mensuration.' The simple rules should be demonstrated, and duodecimals ought to be mastered, on account of their practical use to the mechanic.

(VII.) **Algebra.**—The report of H. M. Inspectors, who examined the papers of Queen's Scholars in 1876, states that 'there is very little knowledge of the subject . . . even so simple a thing as the use of brackets is not mastered, and the simplest equation was beyond the reach of almost all candidates.' And again, in 1877, 'almost entire ignorance' is reported. Such unsatisfactory results can only be explained on the supposition that the subject receives little good teaching. (1) It would be well for the pupil-teachers who are good arithmeticians to begin algebra in their second year. The hurried way in which pupils are necessarily prepared, when mathematical subjects are left to a late point in their training, will itself account for failure. The *earlier parts—easy, but most essential to after success*—are not well

digested, and so it often happens that a pupil reaches quadratics before he can solve an easy case of resolution into factors. We advise, then, much careful grounding in the various symbols and their significance, and clear explanation of the reason of every elementary process. (2) There are certain critical points in the early stages which may be named as requiring patient teaching. These are the 'rules of signs,' the 'rule for subtraction,' the 'general results' of multiplication and division, and their application to involution and factors, and especially the solution of questions in G. C. M. and L. C. M. by means of factors. Todhunter's 'Algebra for Beginners,' and Hamblin Smith's 'Algebra,' are both good, but we would especially recommend Part II. of 'The Pupil-Teacher's Course of Mathematics,' published by the National Society, as the best book for a pupil-teacher.

(VIII.) **Euclid.**—The results of instruction in theoretical geometry are not of a more encouraging kind than those reported for algebra. Progress here, as well as in arithmetic and algebra, depends so much on the teacher's grasp of the subject, that until the general range of attainments is somewhat higher among elementary teachers than at present, little improvement can be expected. Fortunately, since Christmas, 1878, no acting teacher can obtain a certificate *qualifying him to instruct pupil-teachers* 'unless he shows a competent knowledge of geometry.' We can afford space for a few brief hints. (1) The definitions will not be fully comprehended by the average pupil-teacher unless some trouble is taken to explain their meaning and value. (2) Take pains, by much black-board teaching and frequent repetition, to get the first eight propositions of Book I. mastered. The fourth proposition can be easily illustrated by triangles actually cut out in paper; the fifth will present little difficulty where the fourth is really mastered; the indirect method of the sixth will require careful explanation. (3) Give preference to oral demonstrations at

the black-board rather than written reproduction of propositions; many a weak point will be thus discovered. (4) The safest and best guide both for pupil-teacher and instructor will be Part I. of 'The Pupil-Teacher's Course of Mathematics,' to which we refer the reader for many valuable hints.

(IX.) **Sciences.**—What we have to say under this head is rather by way of warning. The teacher's first duty is to see that the obligatory parts of the Syllabus are well done. There is a great danger of the pupil-teacher's time and strength being frittered away in the useless pursuit of too many subjects. Therefore we would say:—(1) As a rule, reserve the opportunities for scientific instruction as a reward for the third and fourth-year pupil-teachers whose progress and diligence have been satisfactory. (2) Do not permit a pupil-teacher to take up more than one science subject during the year, and insist upon an 'advanced course' in the old subject in preference to a new subject. (3) Do not permit your pupil-teacher to 'cram' science from a cheap manual, with a view to securing an additional science certificate. If he is to study science, let him have the full advantage of the valuable training which, *properly pursued*, it can afford: put him under a competent teacher, and in a class where the teaching is *experimental* and *thorough*.

(X.) **Languages.**—A choice of four languages is now permitted the candidate for a Queen's Scholarship. Latin should be preferred on account of its wide utility to the student. Good grammars and exercise books are so common that we need not specify them here. Pupil-teachers intending to proceed to a training college should work conscientiously at Latin and French *grammar*; if they are not well grounded in the grammar, they will make small progress in the college course.

(XI.) **Drawing and Music.**—We have reserved our remarks on these useful branches, because, essential as they are to the well-equipped elementary teacher, they may both be pursued as a relaxation from severer studies.

The theoretical knowledge of music required will make no great demands on either teacher or learner. Some practical skill is now very properly expected, and the *voice*, whether there be much or little, should be cultivated. Attendance at some good elementary choral class will be useful. We here offer no opinion as to rival musical systems; but we do urge upon every head teacher to see that some provision is made for affording the pupil-teachers practical instruction.

The syllabus laid down for the drawing certificate of the second grade is now mastered by many pupil-teachers during their engagement. This subject, like practical instruction in music, is, as a rule, best pursued in special classes and under skilled teachers. The practical points to which head teachers should secure sufficient attention are black-board drawing and sketching from memory—both most useful auxiliaries in class teaching.

CHAPTER V.

PROFESSIONAL TRAINING.

1. **Its importance.**—So far we have regarded the pupil-teacher merely *as a pupil*; we have now to regard him as an *apprentice*, who has to be trained in the principles and practice of a profession. Each Inspector, on his annual visit to a school, is required by the Department to state in Form X. 'the arrangements made for the practical instruction of the pupil-teachers in the art of teaching.'

Possibly the Inspectors, and also the Education Department, recognise the difficulties which in too many instances beset the adequate performance of this important duty; certainly the inquiries made are not usually of a searching character. The fact remains that many pupil-teachers enter our training colleges whose instructors have never spent an hour of the special time devoted to them in the explanation or discussion of any portion of their duties as teachers; have never once requested them to prepare notes of a lesson; and have left them to 'pick up' in the schoolroom such skill in managing and teaching a class as they may happen to possess. Nobody can pretend that the pupil-teacher system is in a healthy condition while such manifest shortcomings are possible. The point is one of much importance, whether we regard the present or future usefulness of the pupil-teacher. (*a*) It determines very largely the character of the work which these young people are able to perform; for they are, one and all, taking a share in the work of our elementary schools. (*b*) Many

pupil-teachers, at the end of their engagements, go out as assistant teachers, and may afterwards, *without further training*, sit for certificates, and become in turn instructors of pupil-teachers. (*c*) The utility of the colleges as places for training *skilled teachers* depends not a little on the amount of practical experience and skill in teaching which the students individually take with them. The average period a student spends in the practising school is about six weeks. This is found amply sufficient for well-prepared teachers, but it is altogether insufficient in the case of students whose practical training has been neglected during apprenticeship.

The authorities of training colleges have ample proof in the number of skilled and intelligent teachers whom they receive amongst their students, that many head teachers are both able and willing to attend to the professional training of their pupil-teachers; but in the case of very many more there are evidences of great neglect. It remains with the Education Department to take such measures as shall tend to remove this grave defect, and ensure to every pupil-teacher efficient training in the art of teaching.

2. **What should be attempted?**—At the outset we wish it to be clearly understood that what is required is far more important than the perusal or discussion, at stated periods, of the contents of some manual of method; this may be safely reserved until the last two years of engagement. What is really essential is regular instruction, helpful direction, and constant supervision for each pupil-teacher in the daily round of duties which fall to him. (*a*) *Entrust each pupil-teacher only with such duties as are suited to his age and experience.* The engagement of many a pupil-teacher is from beginning to end a dreary struggle with difficulties. As a beginner he is often placed in sole charge of a junior class, where special tact, great patience, and much skill are necessary; ofttimes he is made responsible for a division which would afford sufficient scope for the energies and

matured skill of an adult teacher. We have already (see Chap. II.) pointed out the use which should be made of probationers; the same plan should be continued for the first two years of the engagement. The young pupil-teacher should be the assistant of a responsible senior, and should never be put in sole charge. (*b*) *Give specific directions for the performance of each duty.* What the young pupil-teacher needs most is to be drilled into proper methods of performing the simple duties entrusted to him. Plain directions must be given him; and when these are understood, he must be made to carry them out to the letter. This is necessary in matters of *order*—the movements of a class, and the delivery and collection of books or apparatus; and it is equally necessary in the matters of *discipline*, and for the due execution of any simple *teaching* work that may fall to him. The pupil-teacher is in the position of a trade apprentice, who must carry out strictly the 'practice of the workshop;' the inexperience of the learner will permit no other course of procedure.

(*c*) But if there is to be any growth of intelligence as well as of practical skill—nay, if practical skill is ever to attain perfection—something more is needed besides a rigid adherence to customary plans. The oft-used method will assume renewed interest, and be pursued with renewed zeal, when the learner is shown the principle which underlies it. Hence we strongly recommend the head teacher to reserve half an hour in each fortnight for *oral instruction* in *the various plans and methods* used in the school. He will then have regular opportunities of explaining the plans he wishes carried out, and why he chooses them to the exclusion of others. Our own method is to give out some question on the practical details of teaching or school-keeping, and to discuss in class the written answers.

(*d*) Do not be content with testing the success of the work of your pupil-teachers: in these days, when *results* are so important, there is little fear of neglect in this point.

Watch them at work, notice their defects in manner and bearing, observe where they are strong and where they fail as teachers, encourage them by a word of praise when it is deserved, and point out privately their causes of failure.

(*e*) *Arrange for the careful preparation of all the lessons to be given by pupil-teachers in which direct oral teaching forms a part.* As a rule, pupil-teachers should not be permitted to give oral lessons until their third year, and then only when '*notes*' are given in as evidence of careful preparation. These notes should not be restricted to lessons in geography, grammar, object lessons, &c., but they should also be prepared for explanatory lessons in arithmetic, the exposition of reading lessons, and for dictation lessons. An article on 'Notes of Lessons' would be foreign to the purpose of this little manual. We will merely state that if there be any advantage in the careful preparation of class lessons, then every head teacher ought to make the writing of 'notes of lessons' a standing feature in the work of the pupil-teachers. Some Inspectors now follow the commendable plan of requiring each pupil-teacher to produce all the notes prepared during the year. In any case it is well they should be preserved; the teacher's corrections and suggestions will form useful landmarks for future guidance; and the notes themselves, whether they be mere 'outlines' or 'full notes,' will form a collection of useful materials for after use.

(*f*) *As far as possible, let your pupil-teachers have the benefit of occasional model and criticism lessons.* If the staff be large and efficient, there can be no good reason why the pupil-teachers should not have specimen lessons from the head-teacher. In addition to these occasional model lessons, each pupil-teacher in turn should be called upon to prepare and give a lesson to a class, before the head teacher and the pupil-teachers. Whenever these lessons are provided for, they are found to encourage and develope an intelligent interest in the principles and practice of the

teaching art. Each pupil-teacher should be called upon to express an opinion upon the lesson. Captious remarks are readily checked if the head teacher insists upon a 'reason' being furnished, or a 'better method' suggested, in each case of adverse criticism. The head teacher will of course sum up methodically the merits and defects of the lesson, never forgetting to bestow warm words of encouragement for marks of special care, or improvement on previous attempts.

And here we can imagine some reader remarking, 'How can the hard-pressed master or mistress, working with a staff both small and inefficient, arrange for model or criticism lessons?' We reply that, even under these adverse circumstances, the plan we suggest is not impossible. We know more than one hard-worked teacher who, at stated intervals, keeps back a class from 12 to 12.20 or 12.30, so that his pupil-teachers may be taught 'how to teach.' And the marked success, both of the schools and of the pupil-teachers, affords proof that the time thus devoted is profitably and wisely spent. We readily acknowledge the difficulty of carefully supervising the school-work of the pupil-teachers when the head teacher's hands are more than full. But the difficulties cannot free him from the responsibility he has voluntarily taken upon himself *to train* his pupil-teachers; they only render it the more imperative that he should use to the best advantage such brief opportunities for supervision as may arise. A few minutes devoted to a swift inspection of each class; a quiet word of encouragement here, of correction or of direction there, even these will be helpful; and the practised eye of the head teacher will notice many things which may advantageously be reserved and talked over after school is dismissed.

(*g*) So far, we have not made any reference to the requirements of the Department as expressed in the Syllabus. Pupil-teachers are required to show in succeeding years increased skill as teachers and disciplinarians, and, at last,

teaching skill is permitted to hold some numerical value in marks in the Queen's Scholarship examination. A paper of practical questions on teaching and school management also forms part of the same examination. While we hold that the professional training suited to a pupil-teacher is that which is furnished by his practical experience in school, and the direct instruction of the head teacher, yet a good text-book will form a useful auxiliary, especially in the last two years. The pupil will then be prepared to profit by the wider views and diverse opinions and practices which the text-book will furnish, and which to the beginner would be a source of confusion and uncertainty. The first and second of the series of 'Manuals on Teaching' to which this little book belongs, contain works written specially for the use of pupil-teachers and other young students. Those on 'Class Teaching,' on 'How to teach Reading and Writing,' on 'How to teach Arithmetic,' together with the Manuals on Geography, Grammar, History, and School Furniture and Apparatus, will be found especially useful to pupil-teachers. We also recommend every head teacher to procure copies of Saunders's 'Practical Hints on Class Management,'—a book for pupil-teachers, which contains a large fund of common-sense upon matters personal as well as professional, and is written in a style to attract young readers.

3. Head teachers should try to give *completeness* to the professional training of their pupil-teachers so far as circumstances will permit. (*a*) As the powers of the pupil-teacher develope, opportunities of practising in every department of the work of elementary teaching should be afforded him. (*b*) Teach him the powers of his *tools* and how to use them. It is not uncommon to find a pupil-teacher after four or five years' training (?), who does not know where to place a black-board or map before a class, nor where he may best stand so as to teach and control; nor how to write legibly, or draw a simple map from memory

on the black-board. (*c*) Let him learn the value of the different teaching expedients—when simultaneous and when individual methods should be used; when and how to use experiments, models, maps, pictures, and black-board diagrams as means of illustration; when and how he should ask questions, and when he should explain. (*d*) Teach him such practical parts of school-keeping as registration, and the construction of simple time-tables, and let him learn something of the principles which underlie the methods of organisation and classification carried out in his own school. He will then be prepared to profit by the more systematic and scientific instruction in the principles of his profession which the training college will provide.

CHAPTER VI.

MORAL AND RELIGIOUS TRAINING.

THERE is no profession where there is greater need of a high standard of moral excellence than in that of the elementary teacher. He is entrusted in the greater number of schools with the religious instruction of the children, and in all he is held responsible for their moral training. It is impossible that these onerous duties can be adequately discharged unless the teachers themselves are under the influence of religious principles. 'The teacher whose life is a worthy example for his pupils does more to form their character to virtue than he can do by all his instruction and all his laws.' How important is it, then, that our pupil-teachers, while growing in mental culture and professional skill, shall also be developing high moral characters and true religious spirit.

On the head teacher and the managers rests the responsibility of nominating the candidate pupil-teacher, and their choice, as we have pointed out in Chapter II., should be in a great measure determined by high personal character. But when the candidate is appointed, the head teacher's responsibilities as regards moral training are only just beginning: henceforward, probably no one will have an equal opportunity of influencing the character of the pupil-teacher. We will try to show the important position which the teacher's own example holds in this work of moral training. (1) *The personal character of the head teacher is the most powerful external influence which can affect*

the pupil-teacher. Our instruction will have no moral weight unless our pupils have faith in our sincerity of purpose. They soon discover the motives that guide us in our work, and whether our own lives are influenced by the principles we seek to instil into them. Our rigid adherence to strict honesty in the many small matters of school administration, our patience with the dull, our courtesy towards the poor or troublesome parent, the character we bear as citizens, the occupations which fill our leisure time—consistency in these things will gain for us that personal respect and confidence, without which our religious instruction will have little practical value.

(2) The nature of our personal relations with our pupil-teachers is a powerful element in their training. Something more than a high example of integrity is necessary: the pupil-teachers must see in the head teacher a personal friend whose interest in their welfare is not merely official. If the head teacher can only gain the affectionate esteem of his subordinates, his reproofs will have double force, his counsel will never be despised, and he will win the pupils to respect and esteem those principles which they see exemplified in him. (3) We should constantly impress upon our pupil-teachers the importance of the moral and religious bearing of their work. It is not to be supposed that our mere verbal declaration of this fact will suffice. They must perceive it influencing every phase of discipline and instruction in the school; and, perceiving it, they will themselves receive a useful moral impetus.

Religious Instruction.—The instances where head teachers have no share in the religious training of their pupil-teachers are happily very few. The Church of England has provided ample organisation for directing and encouraging the religious education of pupil-teachers. Each diocese has its own Inspector, who arranges a syllabus of instruction, visits each church school yearly, and holds col-

lective examinations of the pupil-teachers. Similarly, the Wesleyans have prepared a scheme providing the opportunity of annual examination in a pre-arranged syllabus of instruction in Holy Scripture and their catechism of Wesleyan doctrine. Many school-boards, too, have recognised the necessity for providing religious instruction for their pupil-teachers, and have prepared careful schemes for Bible study, and have also directed their head teachers to devote an additional hour per week to this special work. So far, then, as organisation can provide, there is no fear of the work of religious instruction being neglected. Happy will it be for the future of National Education if head teachers one and all rise up to a full appreciation both of the duty and the privilege thus placed before them. (1) First, then, we will say, *Do not assign this special work to any subordinate position in your general scheme of preparation.* Give it a prominent place in each week's work, pursue it regularly throughout the year, and do not permit any pressure of secular work to displace it from its proper position. (2) Let at least the same diligence and attention to order and method, which mark your interest in the secular work, accompany the religious instruction. No mere enforced or perfunctory discharge of these duties will be of any avail; better, indeed, would it be for the teacher to ignore them altogether than to perform them in a spirit so unworthy. (3) *Endeavour to set before yourself, as the primary purpose of all your religious instruction, the cultivation of a sincere and devout religious spirit.* This is not a matter in which we can attempt to lay down rules. Its only possible source is the depth and sincerity of the teacher's own religious principles. From these will proceed an earnest and reverent demeanour, an affectionate desire to make the lessons a means of spiritual advancement, and the power to move your pupils' sympathies and mould their characters. (4) See that your religious teaching is accompanied with all the necessary means and appliances for profitable study. History, geo-

graphy, natural history, antiquities, manners and customs, travels,—all must be laid under contribution to throw light upon God's Word: the catalogues of the societies which interest themselves in religious education will afford a large choice of cheap and sound manuals. A reference Bible with maps, and some good Bible Handbook, should be provided for each pupil-teacher, and the school reference library ought to contain a useful commentary, such as that published by the Society for Promoting Christian Knowledge, Smith's 'Smaller Bible Dictionary,' some standard book of Eastern travels, and books like Jamieson's 'Eastern Manners and Customs,' or Kitto's 'Daily Bible Illustrations.' Maclear's class books in Old and New Testament History will also be found a useful addition to each pupil-teacher's stock of text-books.

CHAPTER VII.

THE RELATIONS OF HEAD TEACHERS AND MANAGERS TO PUPIL-TEACHERS.

1. **The personal relations between head teachers and their pupil-teachers.**—These relations have already been considered so far as they bear directly on the moral and religious training of pupil-teachers. In this brief chapter we wish to show that there are many ways in which a head teacher may, outside the faithful discharge of prescribed duty, lend valuable services to his subordinates, if he will only 'act the part of a friend as well as a master.'

(1) The head teacher should have much *sympathy* with his young assistants. On every side we hear it acknowledged that the position of pupil-teachers is not an easy one; nobody can do so much as a kind and sympathising master or mistress to make their path smoother and pleasanter.

(2) *Treat them with confidence.* This is due to the position of trust in which they are placed, and nothing will be more likely to secure continued trustworthiness, or to strengthen their authority as junior teachers.

(3) Have a careful regard to their *physical well-being.* (*a*) As far as you can, arrange the time tables so that lessons making heavy demands on their physical powers may alternate with less severe employments. (*b*) The head teacher's watchful oversight should lead him to attend to ventilation, unhealthy posture, unhealthy position as regards draughts or fireplace—points which pupil-teachers constantly overlook.

Mistresses should take care that their pupil-teachers have opportunities of sitting during some portion of each school attendance. (*c*) Take some interest in their open-air recreations, and use your influence to secure their attention to the necessity for regular out-of-door exercise. (*d*) Endeavour to arrange their plans of study and preparation so that intense application may not be necessary towards the end of the year. (*e*) Do not encourage 'holiday tasks;' your pupil-teachers need these periods for entire relaxation and change.

(4) Take a kindly interest in their *general welfare* (*a*) Direct their private reading. Pupil-teachers have little time for general reading; hence there is special need that they should be directed to those books which will afford both genuine refreshment and the means of general culture. (*b*) See they do not form undesirable companionships. Wasted time and general deterioration of character would often be spared a pupil-teacher if the head teacher would give seasonable advice and warning on this point. (*c*) Use your influence to secure for your pupil-teachers a well-spent Sunday. It is inadvisable for them to take any part in Sunday-school work; but their best interests demand that they should be regular attendants at some place of worship.

2. **Managers and pupil-teachers.**—In the circular of January 16, 1878, to H. M. Inspectors, the following words occur: 'The condition of the pupil-teachers of your district should receive your very careful consideration. My Lords have reason to fear that sufficient care has not been bestowed upon them in many cases, either by managers or teachers. You will do well, therefore, to bespeak the special attention of the managers to this important subject.' To this we would add that it is the strange neglect of managers towards their pupil-teachers which renders possible the apathy and negligence shown by some head teachers.

(1) *The position of managers.* It will perhaps be well if we point out the extent of the responsibility of managers. They have to certify to the Education Department as to the fitness of the candidate; *they*, and not the head teacher, are parties to the memorandum of agreement, with its various requirements; they must certify as to health, except at the end of the second year; and they must also certify that the pupil-teachers have received the stipulated amount of instruction. Managers too frequently fill in these returns without having any personal knowledge of the facts which they are attesting.

(2) *Duties of managers.* As regards pupil-teachers these duties may be thus summed up:—The managers ought to exercise *direct personal supervision* over their apprentices. We will briefly indicate how, in our opinion, this may be best accomplished. (*a*) Just as one manager usually acts as 'treasurer,' and attends to 'finance,' and another as 'correspondent,' and attends to general administration, so it would be well if one, having the necessary opportunities and aptitude, would take special interest in the pupil and assistant teachers. He would report on the fitness of candidates from personal observation; he would make himself acquainted with their after attention to studies and to school duties; and he would in many ways find opportunities of aiding the head teachers in a work which is thrown too exclusively upon them. (*b*) It would be well if pupil-teachers appeared occasionally before the managers, with their diary of daily lessons, and the reports of their teacher on their conduct and progress; special commendation could be given to the deserving, or warning to the unsatisfactory pupil-teacher, and the teacher's hands thereby be strengthened. (*c*) Clerical managers ought to make themselves directly responsible for the religious instruction, or of some part of it. (*d*) It would be well if any one of the managers would give the pupil-teachers a half-yearly examination in their work; every good head teacher would

gladly welcome such a useful stimulus to the pupils. (*e*) Managers should do their best to provide a thoroughly efficient staff, so that their pupil-teachers may be neither over-worked nor have duties thrust upon them which they are not fully competent to discharge. (*f*) That personal interest in and sympathy with these young teachers, which we have described as part of the moral obligation of the head teacher, is, to an equal extent, the duty of managers. (*g*) The gradual formation of a useful library, for reference as well as general reading, would be a boon to every staff of pupil-teachers. Managers would directly aid in the work of properly training their young teachers, by promoting so useful a means of intellectual improvement.

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